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SEARCH AND RESCUE
EXPERIMENT TO DERIVE LEEWAY AND DRIFT RATES FOR COMMON SEARCH AND RESCUE OBJECTS NOTRE DAME BAY, NEWFOUNDLAND SUMMER 1989

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TRANSPORTATION DEVELOPMENT CENTRE
POLICY AND COORDINATION GROUP
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16. Abstract

The Search and Rescue (SAR) Leeway Experiment took place in Notre Dame Bay, Newfoundland, during the period from July 19 to September 18, 1989. The CCGS Hood was made available as a research platform.

The primary objectives of the project were to develop a detailed methodology for conducting leeway experiments and to undertake a field experiment to derive the leeway for at least one SAR object under a variety of environmental conditions. A 4-person Beaufort life raft was tested in various configurations of drogued or undrogued and simulating two or four persons aboard.

The experiment was done in winds of 0 to 25 knots and in significant wave heights of 0.1 to 2.1 meters. The leeway was derived by computing the difference between the SAR object velocity and the current velocity of the upper 1 metre (m) of the water column at the object.

The leeway rates for a drogue and undrogued life raft were found to be considerably less than those shown in the National Search and Rescue Manual (National Defence and Canadian Coast Guard, 1985).

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16. Résumé

Les opérations expérimentales de recherche et de sauvetage visant à estimer la dérive due au vent ont eu lieu dans la baie Notre-Dame à Terre-Neuve, du 19 juillet au 18 septembre 1989. Le navire Hood de la GCC a été utilisé comme plate-forme de recherche.

Le projet avait pour but la mise au point d'un mode opératoire d'expérimentation et la conduite d'opérations en mer en vue de déterminer la dérive due au vent pour au moins une cible, et ce dans diverses conditions atmosphériques. Un radeau de sauvetage Beaufort quatre places a été mis à l'essai avec diverses variantes: avec et sans ancre, et simulation de 2 à 4 personnes à bord.

Les opérations ont été menées sous des vents de 0 à 25 noeuds et à hauteurs significatives de houle entre 0,1 à 2,1 m. La dérive due au vent a été calculée en soustrayant de la vitesse d'avancement de la cible la vitesse du courant, mesurée à 1 mètre ou moins de la surface de l'eau, à la position de la cible.

Les valeurs tirées des expérimentations, avec et sans ancre, ont été sensiblement inférieures à celles du Manuel national de recherche et de sauvetage (Défense nationale et Garde côtière canadienne, 1985).

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Commanding Officer Edward Parsons
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First Officer Guy Vanderwaern
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EXECUTIVE SUMMARY

This report presents the results of a Search and Rescue (SAR) Leeway Experiment conducted in Notre Dame Bay, Newfoundland during the period from July 19 to September 18, 1989. The CCGS Hood was made available as a research platform throughout the field experiment.

The primary objectives of the project were to develop a detailed methodology for conducting leeway experiments and to undertake a field experiment to derive leeway guidance for at least one common SAR object under a variety of environmental conditions. Leeway is defined as the movement of a craft through the water caused by the wind acting on the exposed surface of the craft. The leeway is derived by subtracting the current vector from the drift vector.

The United States Coast Guard (USCG) has conducted a number of leeway experiments over the past number of years. Significant differences have been found between experimental observations and those predicted using operational SAR planning practice. Accurate prediction of leeway vectors will enable SAR management to concentrate search resources in smaller areas with an expected increase in the probability of locating and rescuing survivors of a mishap at sea. The anticipated efficiency improvement will also result in a substantial saving in SAR mission costs.

A detailed field experiment methodology was developed to accurately measure the forces and reactions required for the determination of leeway. The parameters to be measured were the velocity of the life raft and the velocity of the wind and current at the life raft, along with significant wave height. The velocity of the life raft was determined from position records obtained from a LORAN-C buoy placed inside the life raft. Similarly the current was determined from an array of LORAN-C drifter buoys deployed in the vicinity of the life raft. The wind and life raft orientation were logged to a wind and compass recording system aboard the life raft. Wave data were recorded from a wave measuring buoy moored at the centre of the experiment area. The current was measured in the upper 1 m of the water column and the wind was measured at 1.6 m above the sea surface. The wind was also measured on the research platform every half hour to serve as a check against the wind being recorded in the life raft. The height of the anemometer on the research platform was 12.9 m above sea level.

The SAR object tested was a pentagon shaped, 4-person Beaufort life raft with a canopy and five ballast chambers. The major dimensions of the life raft were: length, 1907 millimetres (mm); beam, 2005 mm; and height, 1130 mm. The ballast chamber extended 470 mm below the floor. A 500 mm diameter SOLAS'86 non-tangle sea-anchor on a 30 m line was used with the life raft. The life raft was tested in various configurations of drogued or undrogued and simulating two or four persons aboard.

The results show the leeway rate for a drogued and undrogued life raft, in wind speeds less than 5 knots, to be essentially zero. In wind speeds greater than the 5 knot threshold, the leeway rate for a drogue and undrogued life raft are expressed in the following formulae.

Drogued life raft: leeway speed = 0.0338 (wind speed) - 0.1

Undrogued life raft: leeway speed = 0.0471 (wind speed) - 0.1375

With respect to leeway angle, the data clearly shows that in wind speeds greater than the 5 knot threshold the leeway angle approaches a constant of 25° to the right of down wind as the wind speed increases. The addition of ballast to increase the simulated weight from two persons to four persons had no significant impact on the leeway of the life raft.

SOMMAIRE

Ce rapport présente les résultats d'opérations expérimentales de recherche et de sauvetage menées dans la baie Notre-Dame à Terre-Neuve, du 19 juillet au 18 septembre 1989, et visant à estimer la dérive due au vent. Le navire Hood de la GCC a servi de plate-forme de recherche pour la durée des opérations.

Le projet avait pour but la mise au point d'un mode opératoire d'expérimentation et la conduite d'opération en mer en vue de définir une méthode d'appréciation de la dérive due au vent avec au moins un type courant d'objets de recherche et de sauvetage, et ce dans diverses conditions atmosphériques. On entend, par dérive due au vent, le déplacement incontrôlé d'une embarcation sous l'action d'un vent oblique. Elle s'obtient en soustrayant le vecteur de courant du vecteur de dérive.

La Garde côtière américaine (USCG) a mené plusieurs études sur la dérive due au vent au cours des dernières années. Les observations se sont révélées assez différentes des prévisions établies selon les méthodes en usage dans la planification des opérations de recherche et de sauvetage. Une méthode précise de calcul des vecteurs de dérive due au vent permettrait de concentrer les efforts de recherche sur une largeur de ratissage réduite, et d'augmenter par le fait même les chances de succès. Une plus grande efficacité entraînerait par surcroît une diminution du coût des opérations.

Un mode opératoire précis a été mis au point pour mesurer en mer les facteurs en jeu dans les phénomènes de dérive. Il s'agissait de mesurer la vitesse d'avancement du radeau de sauvetage, la vitesse du vent et du courant à la position du radeau et la hauteur significative de houle. La vitesse d'avancement du radeau a été calculée à partir des positions enregistrées par une bouée LORAN-C placée à bord. Celle du courant a été calculée à l'aide d'une batterie de bouées LORAN-C itinérantes, mouillées autour du radeau. La direction du vent et celle du radeau étaient enregistrées par un anémomètre et un compas placés à bord. La hauteur de houle était enregistrée par une bouée spéciale ancrée au centre de la zone d'expérimentation. La vitesse du courant a été mesurée à un mètre et moins de la surface de l'eau et celle du vent, à 1,6 m au-dessus du niveau de la mer. Les caractéristiques du vent ont également été mesurées sur la plate-forme de recherche toutes les demi-heures, pour fins de comparaison avec les mesures enregistrées à bord du radeau. L'anémomètre était placé à 12,9 m au-dessus du niveau de la mer.

La cible utilisée pour les opérations expérimentales de recherche et de sauvetage était un radeau de sauvetage Beaufort 4 places de forme pentagonale, de 1907 millimètres (mm) de longueur, 2005 mm de largeur et 1130 mm de hauteur, équipé d'une tente, de cinq ballasts dépassant de 470 mm le fond du radeau, et d'une ancre flottante de 500 mm de diamètre, de modèle SOLAS 86, reliée au radeau par une ligne de mouillage de 30 m. Les opérations ont été menées avec diverses variantes: avec et sans ancre, et simulation de 2 et 4 personnes à bord.

L'expérimentation a révélé que la dérive du radeau sous l'effet du vent, avec ou sans ancre, était pratiquement nulle lorsque la vitesse du vent était

inférieure à 5 noeuds. Au-delà de cette valeur, elle est appréciable. Elle peut se calculer à l'aide des formules suivantes:

Radeau avec ancre:

$$\text{Dérive}_v = 0{,}0338\ (\text{vitesse du vent}) - 0{,}1$$

Radeau sans ancre:

$$\text{Dérive}_v = 0{,}0471\ (\text{vitesse du vent}) - 0{,}1375$$

Quant à l'angle de dérive, il approche 25° sur la droite de la direction du vent à mesure que la vitesse du vent augmente au-delà de 5 noeuds. Le lestage destiné à simuler la présence de deux et de quatre personnes à bord n'a eu aucun effet sensible sur la dérive due au vent.

TABLE OF CONTENTS

Page

1. INTRODUCTION 1
   - 1.1 Scope 1
   - 1.2 Background 1

2. OVERVIEW 4
   - 2.1 Introduction 4
   - 2.2 Phase I - Preparatory Work 4
   - 2.3 Phase II - Field Experiment 6
   - 2.4 Phase III - Analysis and Reporting 8

3. DESCRIPTION OF VESSEL AND EXPERIMENT HARDWARE 9
   - 3.1 Relevant Characteristics of the CCGS "Hood" 9
   - 3.2 Shipboard Instrumentation and Equipment 9
   - 3.3 Description of SAR Drift Objects 10
   - 3.4 Life Raft Instrumentation and Ballast 10
   - 3.5 Current Drifters 10
   - 3.6 Moored Instrumentation 15
   - 3.7 Life Raft Deployment / Recovery Equipment 15

4. DATA REDUCTION 19

5. ANALYSIS AND RESULTS 20
   - 5.1 Introduction 20
   - 5.2 Life Raft Orientation 21
   - 5.3 Leeway Angle for a 4-Person Beaufort Life Raft 21
   - 5.4 Leeway Speed for a 4-Person Beaufort Life Raft 25
   - 5.4.1 Leeway Speed With Drogue 25
   - 5.4.2 Leeway Speed Without Drogue 25
   - 5.5 Wind Speed 28

6. CONCLUSIONS AND RECOMMENDATIONS 30
   - 6.1 Leeway for a 4-Person Beaufort Life Raft 30
   - 6.2 Wind Speed 32
   - 6.3 Methodology 32
   - 6.4 Research Platform 32
   - 6.5 Experiment Location 32
   - 6.6 LORAN-C Buoys 33
   - 6.7 SAR Objects to be Tested in Future Leeway Experiments 33
   - 6.8 Life Raft Design 33
   - 6.9 New Technology 34

REFERENCES 35

APPENDIX A - DETAILED EXPERIMENT PLAN
APPENDIX B - CRUISE REPORT
APPENDIX C - LIFE RAFT PARTICULARS
APPENDIX D - LORAN-C DRIFTER BUOY SPECIFICATIONS
APPENDIX E - WIND MONITORING SYSTEM
APPENDIX F - MONTHLY REPORTS
APPENDIX G - FIELD LOGS

LIST OF FIGURES

Page

Figure 1 - Experiment Location 5
Figure 2 - Beaufort 4 Person Life Raft (Plan View) 11
Figure 3 - Beaufort 4 Person Life Raft (Front View) 12
Figure 4 - Beaufort 4 Person Life Raft (Side View) 13
Figure 5 - Life Raft Instrumentation Arrangement 14
Figure 6 - Loran-C Drifter Buoy 16
Figure 7 - Waverider Buoy Mooring Arrangement 17
Figure 8 - Life Raft Deployment/Retrieval Apparatus 18
Figure 9 - Relative Wind Direction vs Speed for: Drogued 4-Person Life Raft 22
Figure 10 - Relative Wind Direction vs Speed for: Undrogued 4-Person Life Raft 23
Figure 11 - Leeway Angle vs Wind Speed for: 4-Person Life Raft 24
Figure 12 - Leeway Speed vs Wind Speed for: Drogued 4-Person Life Raft 26
Figure 13 - Leeway Speed vs Wind Speed for: Undrogued 4-Person Life Raft 27
Figure 14 - Ship Wind Speed vs Raft Wind Speed 29
Figure 15 - Comparison of National SAR Manual and Experiment for Leeway Speed vs Wind Speed 31

LIST OF TABLES

Table 1 - Summary of Drift Runs and Environmental Conditions 7

1. INTRODUCTION

1.1 Scope

In December, 1988, NORDCO Limited was awarded a contract by Supply and Services Canada (T8200-8-852/01-SD) on behalf of the Transportation Development Centre (TDC), Transport Canada to conduct a Search and Rescue (SAR) object leeway experiment. The project objective was to conduct field experiments over a multiyear period in order to derive leeway results for a variety of common SAR objects. Leeway is defined as the movement of an object through the water caused by the wind acting on the exposed surface. The leeway results from these experiments are expected to increase the accuracy of drift predictions in actual SAR operations. The results of the project are thus expected to be used to update SAR planning and guidance material provided in the National Search and Rescue Manual (Department of National Defence and the Canadian Coast Guard, 1985). The expected benefit of the work is an improvement in the overall effectiveness of marine SAR operations.

The work of the current contract is the first of a series of leeway experiments to be conducted over a multiyear period and the first of its kind to be carried out in Canadian waters. This first field experiment thus served to develop and establish a methodology to determine the leeway of drifting objects and to collect life raft drift data and concurrent environmental data in Canadian offshore waters.

The experiment was carried out in Notre Dame Bay, Newfoundland, during the period from July 19 to September 18, 1989. The CCGS "Hood" was made available as a research platform for the experiment. The SAR object used in this experiment was a 4-person Beaufort life raft. The life raft was deployed in various configurations of drogued or undrogued, and was ballasted to simulate two or 4-persons aboard.

The overall project was divided into three phases as follows:

Phase I - Preparatory Work
Phase II - Field Experiment
Phase III - Analysis and Reporting

This document constitutes the final report under the terms of the contract. It contains a detailed description of each of the phases listed above. Most importantly, this report describes the results of the experiment along with conclusions and recommendations.

1.2 Background

A prediction of search object drift requires a knowledge of the mean or residual current (sea current), tidal current velocities, the local wind driven current (computed using the local wind history and predicted wind velocities), miscellaneous currents such as longshore currents where applicable, wave induced drift (Stokes transport), and the leeway velocity of the particular search object. Leeway is the component of the total drift caused by the action of the wind on the exposed area of the drifting object. Leeway speed is the speed of the object caused by the wind alone; leeway angle is the angle off downwind that the object will sail. In the past, certain investigators have included the wave induced drift along with the wind effects in their definition of leeway (e.g., Chapline, 1960). The following paragraphs provide a review of previous leeway experiments.

One of the earliest life raft drift investigations to be undertaken was conducted in 1943-44 by the Woods Hole Oceanographic Institute (Pingree, 1944). One to five person inflatable rubber life rafts were used in the experiments which were conducted in winds up 20 knots in three locations: Buzzards Bay, Massachusetts; Gulf of Mexico off Florida; and in the open Atlantic Ocean off the northeast coast of the Bahama Islands. The results for drogued and undrogued life rafts of varying loadings indicated a considerable scatter in the drift rate as a function of wind speed.

In 1959, a leeway study was conducted off Hawaii by the USCG (Chapline, 1960). A wide variety of craft including light and moderate displacement cruisers, outboard runabouts, skiffs, an assortment of fishing vessels, moderate and heavy displacement sailing vessels, and surfboards were used in the experiments. The vessel types were classified into five groups and the leeway rate was given as a fixed percentage of the wind speed for each category. The leeway data were obtained in moderate to fresh winds (11 to 21 knots). Leeway angle was found to vary widely for the craft used; the leeway angle results, as discussed in the paper, are incomplete and provide little useful guidance for SAR operations.

Between 1969 and 1971, the USCG Oceanographic Unit conducted a series of leeway experiments (Morgan et al., 1977 and Morgan, 1978). Comparison of these results with those of Hufford and Broida (1974) show large differences between the derived wind speed versus leeway angle and speed relationships. Morgan (1978) reported that the leeway for a seven-person oblong raft without ballast was 35 degrees to the right of the wind for a 5 knot wind and near zero degrees for wind speeds above 10 knots.

Another leeway experiment was carried out by the USCG Oceanographic Unit in 1978 (Scobie and Thompson, 1979). Six-, twenty-, and twenty-five person life rafts, all with improved ballast systems were tested. One leeway speed equation encompassing all the life rafts was reported. The leeway angle was reported to be less than 30 degrees for 78% of the drift runs.

The USCG Research and Development Centre in Groton, Connecticut undertook a variety of leeway experiments between 1979 and 1981 (Osmer et al., 1982). A number of four- and six-person life rafts were used. Due to the scatter in the data, no conclusions were reached.

The latest work on leeway investigations was undertaken by Nash and

Wilcox (1985) at the USCG Research and Development Centre. A significant difference was found between the leeway of lightly ballasted life rafts and more heavily ballasted life rafts, with the leeway speed of the latter being much slower. The leeway direction of the lightly ballasted life rafts was dependent on the orientation of the life raft, while the heavily ballasted units drifted directly downwind. During the experiment, the wind speeds ranged from 2 to 11 knots with waves of zero to 2 feet. Once again, there was a great deal of scatter in the data.

Regarding accuracy of drift predictions, a series of experiments was conducted by the USCG Research and Development Centre between 1979 and 1981 to evaluate the accuracy of drift predictions using the US Computerized Search and Rescue Planning (SARP) system. Historical current information provided the current data base. Of the 680 drift predictions that were evaluated, the drift object position was within the SARP predicted area in only 41 cases (6%).

It is apparent that further work is required to improve SAR drift prediction capability. The proposed experiment is expected to help clarify leeway rates and directions for 4 person life rafts. At the present time, the leeway rates provided by Chapline (1960) and those reported by Scobie and Thompson (1979) serve as the primary leeway speed guidance given in the National Search and Rescue Manual (Department of National Defence and Canadian Coast Guard, 1985).

2. OVERVIEW

2.1 Introduction

The project was divided into three phases to facilitate logical planning and to provide significant milestones through which progress could be clearly monitored. The activities of all three phases are summarized in the following subsections.

2.2 Phase I - Preparatory Work

This phase involved the detailed planning and preparation necessary to carry out a successful field experiment. A detailed report on this phase is provided in Appendix A. The following discussion summarizes the major activities during Phase I.

The phase began with a start-up meeting attended by representatives from TDC, CCG, and NORDCO. It was decided at this meeting to limit the SAR objects to four- and six-man canopied life rafts for this initial experiment. Small inflatable life rafts were selected since they are commonly carried aboard small fishing, commercial, and pleasure craft and because they were believed to experience relatively high leeway speeds. In addition to an investigation of drift and leeway, the approach and methodology was to be evaluated in order to benefit future experiments.

The selection of a vessel, experiment location and time frame were somewhat interrelated. During early discussions with the Newfoundland region of the CCG, Captain William Nash suggested using the CCGS "Hood" which was stationed in Twillingate, Notre Dame Bay. After further investigation, it was decided that both the ship and its area of operation met the criteria required for the field experiment. The experiment area selected was enclosed in a twelve mile diameter circle centered approximately eleven and one half nautical miles north-northwest of Twillingate (Figure 1). The CCGS "Hood" was made available for the field experiment for July and August of 1989, except when tasked for SAR operations.

During this phase, a detailed field experiment methodology was developed to accurately measure the forces and reactions required for the determination of leeway. The parameters to be measured were the velocity of the life raft and the velocity of the wind and current at the life raft along with wave height and direction. The velocity of the life raft was determined from position records obtained from a LORAN-C buoy placed inside the life raft. Similarly the current was determined from an array of LORAN-C drifter buoys deployed in the vicinity of the life raft. The wind and life raft orientation were measured and logged aboard the life raft

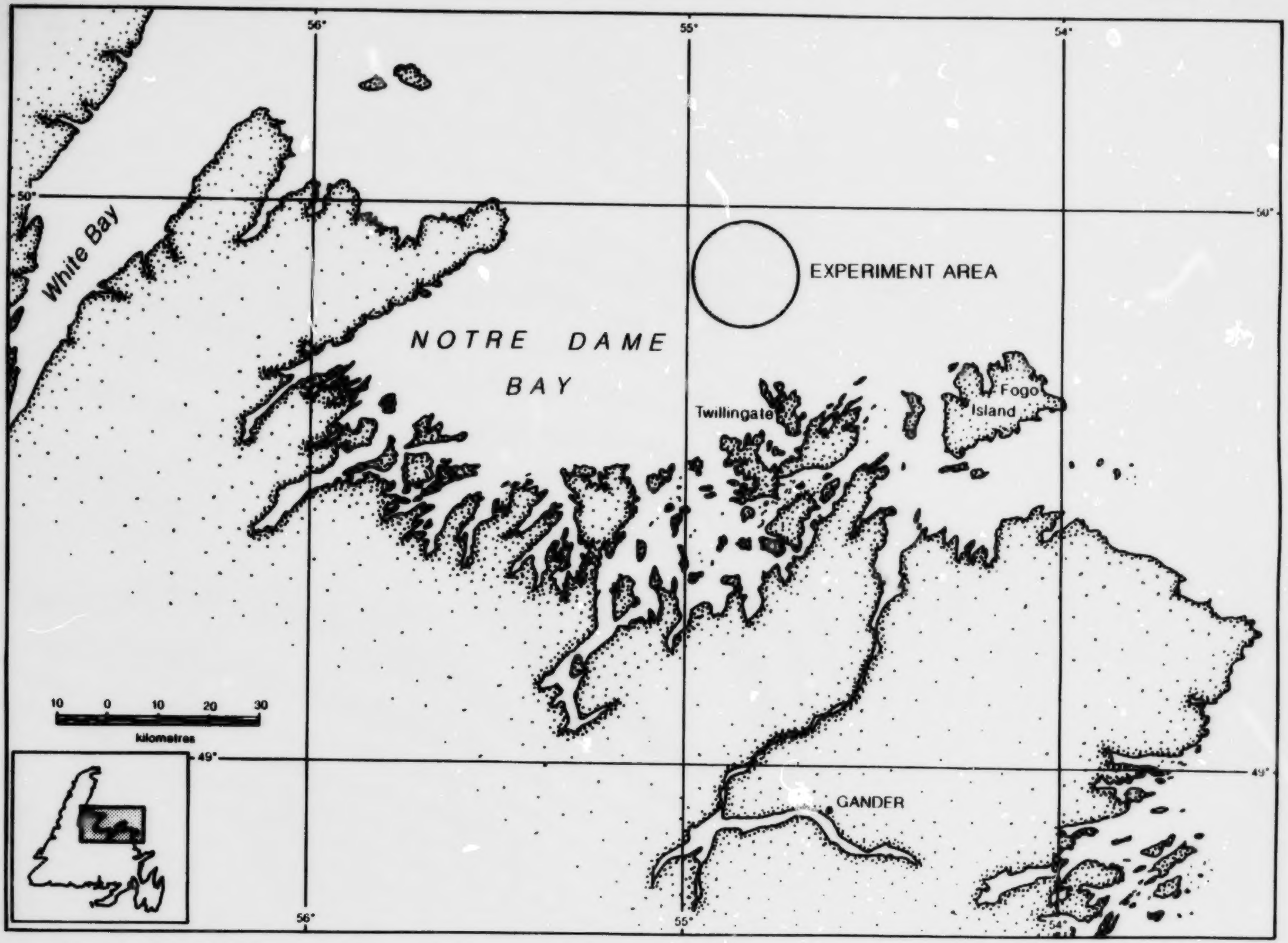


FIGURE 1 Experiment Location

using a wind/compass recording system on loan from the USCG. A similar system was used for measuring the wind at the research vessel. Wave data was recorded from a wave measuring buoy moored at the center of the experiment area. In addition, a device was developed for deploying and retrieving life rafts fully loaded with ballast and instrumentation.

The navigation hardware aboard the ship consisted of a Candel Industries Limited data receiver, an Internav LC-360 receiver and a Campaq Portable II microcomputer. A software package was developed to log and process raw data sent to the microcomputer from both receivers. Included was a graphics display of the life raft and drifter buoy tracks, together with the course and speed of the drifting objects and their relative positions to each other and the vessel. This display facilitated the management of the current drifter array around the life raft.

The sourcing, acquisition and testing of all major equipment and instrumentation was ongoing during this phase. Four LORAN-C drifter buoys were purchased from Candel Industries Limited and tested with the navigation software developed by NORDCO Limited. Two R.M. Young anemometer systems complete with Digicourse fluxgate compasses and Omnidata Polycorders were acquired on loan from the USCG. The wave measuring system was leased from Seakem Oceanography Limited and its deep water mooring was designed and fabricated by NORDCO Limited. Two four-man and two six-man Beaufort life rafts that were purchased for the SAR '88 Detection Experiment were refurbished and fitted with floors to facilitate the mounting of instrumentation. A life raft deployment/retrieval device was designed and fabricated at NORDCO Limited facilities.

A detailed experiment schedule was submitted to TDC and CCG on May 25, 1989. The initial start date for the field work was June 1, 1989, but after several schedule adjustments work began on July 19, 1989. This was a consequence of the delayed delivery and technical problems with the Sea Rover 3 LORAN-C drifter buoys.

2.3 Phase II - Field Experiment

This phase was comprised of the deployment, positioning and tracking of SAR objects to acquire field data for different wind strength and sea conditions. Included in this phase was the mobilization and demobilization for the field experiment. A detailed chronology of events for the field experiment is provided in the Cruise Report in Appendix B. A summary of the drift runs and environmental conditions is shown in Table 1.

The field work was carried out in three distinct phases beginning on July 19, 1989, and ending on September 18, 1989. Mobilization of the vessel at Twillingate, Newfoundland, and initial field trials on Notre Dame Bay, that included two drift runs, were conducted from July 19 to July 28, 1989. Modifications, testing, and repair of certain equipment, and some modifications to software were done in St. John's during the period July 31 to August 16, 1989. From August 17 to August 31, 1989, a series of 9 drift runs were conducted off Twillingate. Following a break of one week when additional software modifications were made, the field work was

RUN NUMBER	DATE 1989	START TIME (GMT)	END TIME (GMT)	DURATION (hour : minute)	LIFE RAFT CONFIGURATION	NUMBER OF PERSONS IN LIFE RAFT	WIND DIRECTION	WIND SPEED (knots)	SEA DIRECTION	SEA HEIGHT (metres)	CURRENT DIRECTION	CURRENT SPEED (knots)
2	JUL 27	1114	2027	9:13	D	2	SW-E	3-11	NE	0.2-0.4	E	1.0
3	AUG 20	1253	2028	7:35	D	2	SW	12-19	SW	0.6-0.8	SE-S	0.8
4	AUG 21	1738	2255	5:17	D	2	S	7-12	N-W	0.5-0.8	SE-SW	0.8
5	AUG 22	1247	2123	8:36	D	2	N	8-17	N	0.8-1.1	S-SW	0.8
6	AUG 24	1157	2050	8:53	D	2	N-E	4-10	N	1.3-1.5	ESE-NE	0.4
7	AUG 25	1142	2045	9:03	D	2	SW-SE	8-20	SW	1.0-1.4	E	0.4
8	AUG 26	1636	2110	4:34	D	2	VRBL	3-9	N	1.6-2.0	SE	0.5
9a	AUG 28	1109	1730	6:21	D	2	WNW	9-21	WNW	1.8-2.1	E	1.1
9b	AUG 28	1730	2020	2:50	U	2	NW	3-11	WNW	1.8-2.0	E	1.2
10	AUG 29	1703	2055	3:52	U	2	S	8-15	N	1.0-1.2	ESE	1.5
12	SEP 10	1158	2055	8:57	U	2	SW-NE	2-15	ENE	0.5-0.7	E-SE	0.8
13	SEP 11	1157	2003	8:06	U	4	SW-NNE	3-14	NE	1.1-1.5	E	0.8
14	SEP 14	1359	1812	4:13	D	4	WNW	13-25	WNW	1.0-1.3	SE	1.0
15	SEP 16	1209	2044	8:38	D	4	NW-E	9-25	NW	0.7-2.0	E-S-W	1.2
16	SEP 17	1142	1817	6:35	D	4	SW	8-17	SW	0.6-1.5	ENE	1.9

TABLE KEY : D = DROGUE STREAMED
U = DROGUE NOT STREAMED

TABLE 1 SUMMARY OF DRIFT RUNS AND ENVIRONMENTAL CONDITIONS

resumed. Between September 8 and September 17, 1989, a further 6 drift runs were conducted. Instrumentation and equipment was then removed from the vessel. The field party returned to St. John's on September 18, 1989.

2.4 Phase III - Analysis and Reporting

During the field experiment a diary of events was maintained by the party chief. Immediately upon return from the field a summary report detailing the events was prepared. This document was supplemented with data on the meteorological and oceanographic conditions experienced during the drift runs and with relevant figures showing the experiment area, typical deployment arrangement and sample drift trajectories. This information is detailed in the Cruise Report provided in Appendix B.

Following completion of the field work, the field data was assembled and reviewed. Following an initial quality control check the data was entered into disk files on the NORDCO Limited DEC VAX 11/750 computer system. Following further quality control checks, analysis of the drift data was carried out. The analysis methodology and results are described in Part 5. The conclusions and recommendations are given in Part 6.

3. DESCRIPTION OF VESSEL AND EXPERIMENT HARDWARE

3.1 Relevant Characteristics of the CCGS "Hood"

The vessel has an overall length of 24 m and a beam of 7.6 m. Deck space is minimal but was adequate for the management and stowage of project equipment. The after deck is equipped with a PM Autogru crane and an inflatable runabout. The crane, with a safe working load of 1400 kilograms (kg) at 7.5 m reach, was adequate to handle the ballasted life raft and wave buoy mooring equipment. The low freeboard facilitated the handling of equipment over the side.

Immediately forward of the afterdeck is the survivor receiving area and first aid station. This area is equipped with a berth and several lockers above the berth. This space was sufficient to support project requirements for navigation equipment, wave monitoring equipment, computer systems, and ancillary gear. Antenna leads and the anemometer signal cable were led along an adjacent stairway to the bridge deck then, from there, to the monkey island and the mast. There was no requirement for equipment space in the wheelhouse.

The normal ships complement is 7 persons. In addition to crew accommodation, the vessel has a "survivors" cabin which has 8 berths, a head, and a desk. The survivors cabin was made available for project personnel. The galley/mess facilities were found to be adequate to handle project personnel in addition to the normal complement.

3.2 Shipboard Instrumentation and Equipment

The following instrumentation and equipment was installed on board the CCGS "Hood":

1. one Internav LC-360 LORAN-C receiver and antenna;
2. one Candel Industries Limited VHF Receiver 2 Data Communications Receiver;
3. two Compaq Portable II microcomputer systems and OKIDATA Printer;
4. one Datawell Diwar receiver and Compaq microcomputer system complete with printer;
5. one fluxgate magnetic compass unit;
6. one Omnidata Polycorder data logger unit;
7. meteorological equipment including:
    a. one R.M. Young anemometer system;
    b. two marine screens containing wet and dry bulb thermometers;
    c. sea temperature bucket with thermometer, and;
    d. one aneroid barometer;
8. life raft deployment/recovery equipment and repair kit;
9. one 35 mm camera equipment;
10. video equipment.

As indicated above, the shipboard equipment was installed in the first aid area on the main deck.

3.3 Description of SAR Drift Objects

A four-man life raft and a six-man life raft were selected as common SAR objects to be used in this experiment. Both life rafts, which were manufactured by Beaufort, were canopied and fitted with ballast chambers and inflatable floors. Two of each of these life rafts were taken into the field but it was only possible to collect leeway data for the four-man life raft. The life raft was deployed with and without a drogue and ballasted to simulate two or four persons aboard. Illustrations of the 4-person life raft is shown (Figures 2, 3 and 4).

3.4 Life Raft Instrumentation and Ballast

To facilitate the mounting of navigation and wind measuring instrumentation packages each type of life raft was fitted with a floor fabricated from 3/4" plywood and 2 x 3" spruce ribs. The edges of the plywood were dressed and trimmed with foam pipe insulation to prevent chafing of the life raft. Also, to maintain the submerged profile of the life raft, a dummy gas bottle was installed in the pocket provided on the bottom of each life raft.

The navigation instrumentation consisted of a Candel Industries Limited Sea Rover 3 LORAN-C buoy with an integral VHF transmitter. The buoy was secured to the floor on its side and the antenna was mounted remote from the buoy to avoid contact with the anemometer. A weather-tight penetration was fitted into the canopy to facilitate installation of the antenna.

The wind measuring system included a R.M. Young anemometer system, a fluxgate magnetic compass unit and an Omnidata Polycorder data logger. The existing lookout opening in the canopy, located at the opposite end of the life raft from the drogue attachment point, was utilized for mounting the anemometer. The anemometer height was 1.6 m above the sea surface.

The weight of persons and survival equipment in the life raft was simulated by the weight of the floors and instrumentation plus ballast material. The ballast was composed of sand-filled automotive tire inner tube segments, weighing 22.68 or 11.34 kg, which were distributed around the instrumentation. Drift runs were made simulating 2 or 4 persons aboard and using 79.38 kg per person. An illustration of an instrumented four-man life raft is shown (Figure 5).

3.5 Current Drifters

The surface current field was measured by tracking an array of Sea Rover 3 LORAN-C drifting buoys deployed in the waters surrounding the free drifting life raft. Three buoys were normally deployed along with the life raft. The Sea Rover 3 buoys contain a LORAN-C receiver and a VHF transmitter. These drifting buoys were identical to the unit secured inside the life raft.

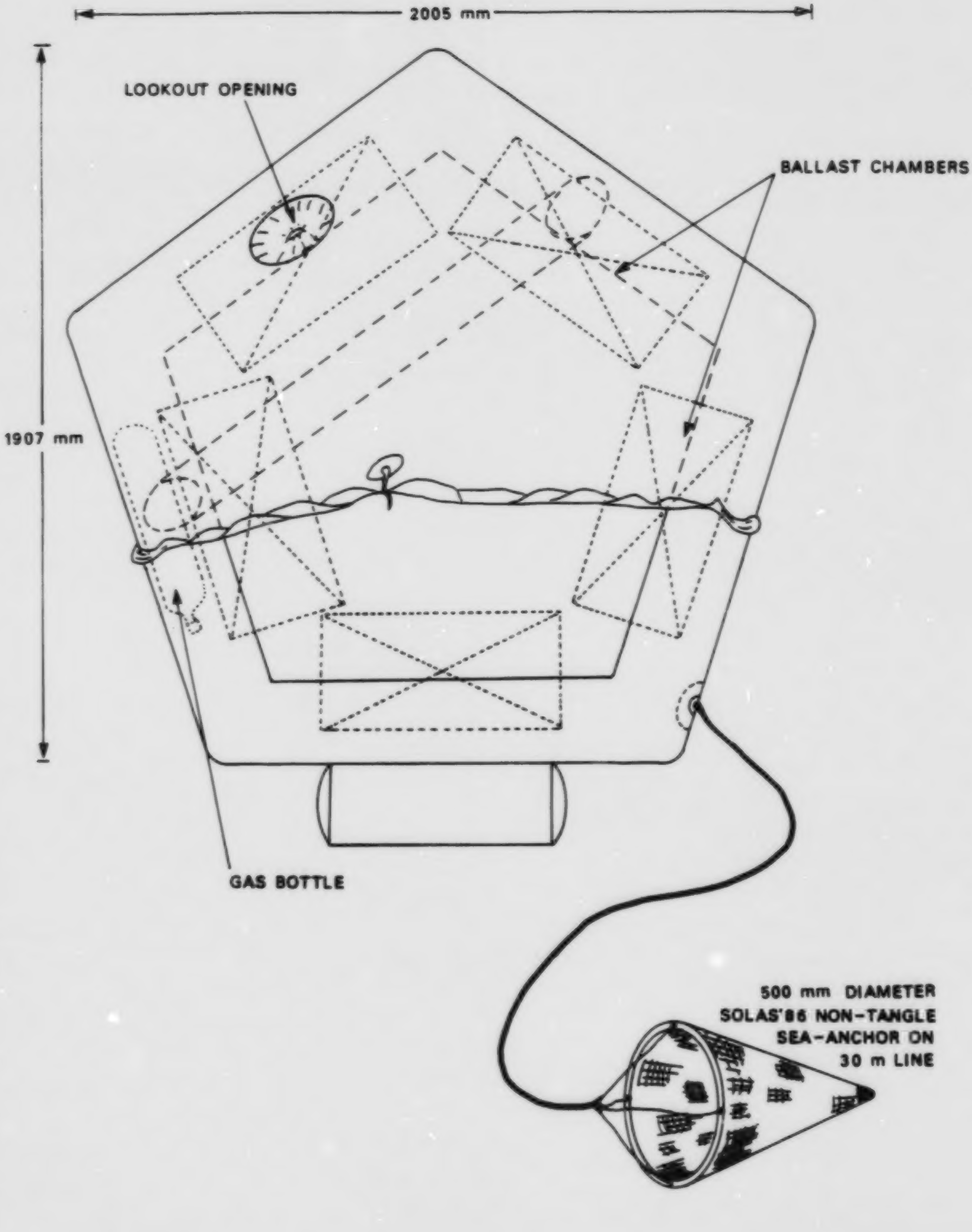


FIGURE 2 Beaufort 4 Person Life Raft (plan view)

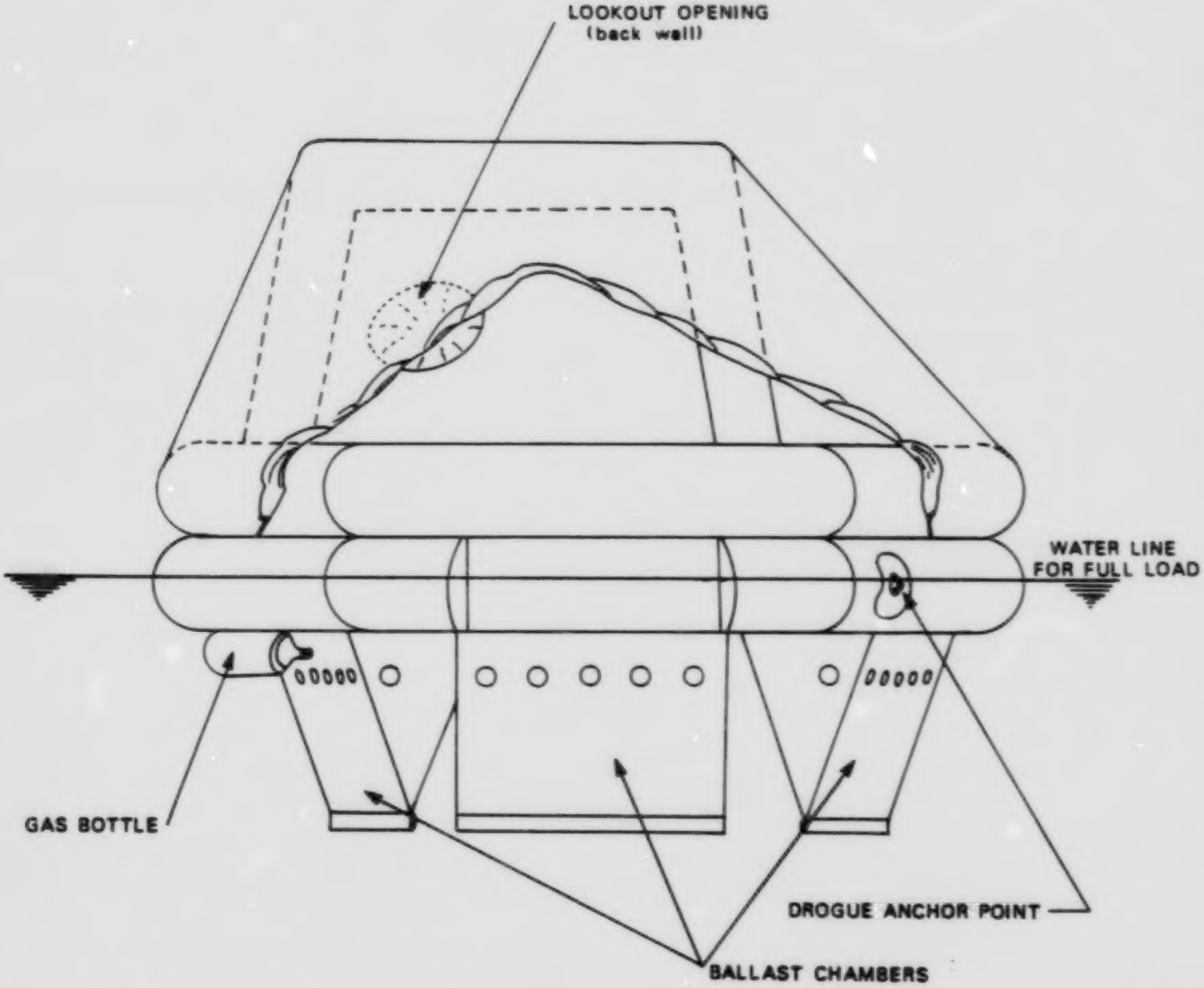


FIGURE 3 Beaufort 4 – Person Life Raft (front view)

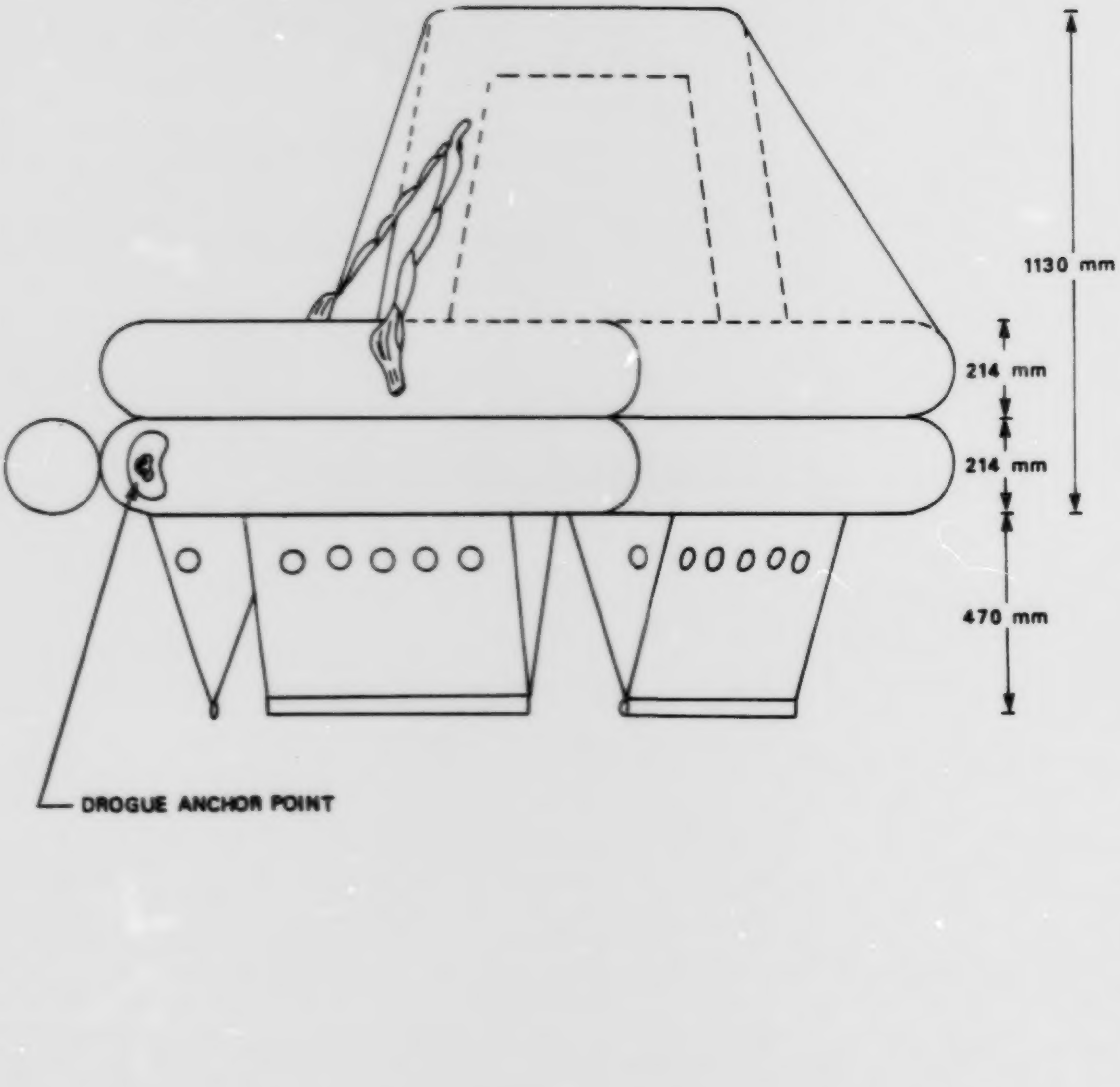
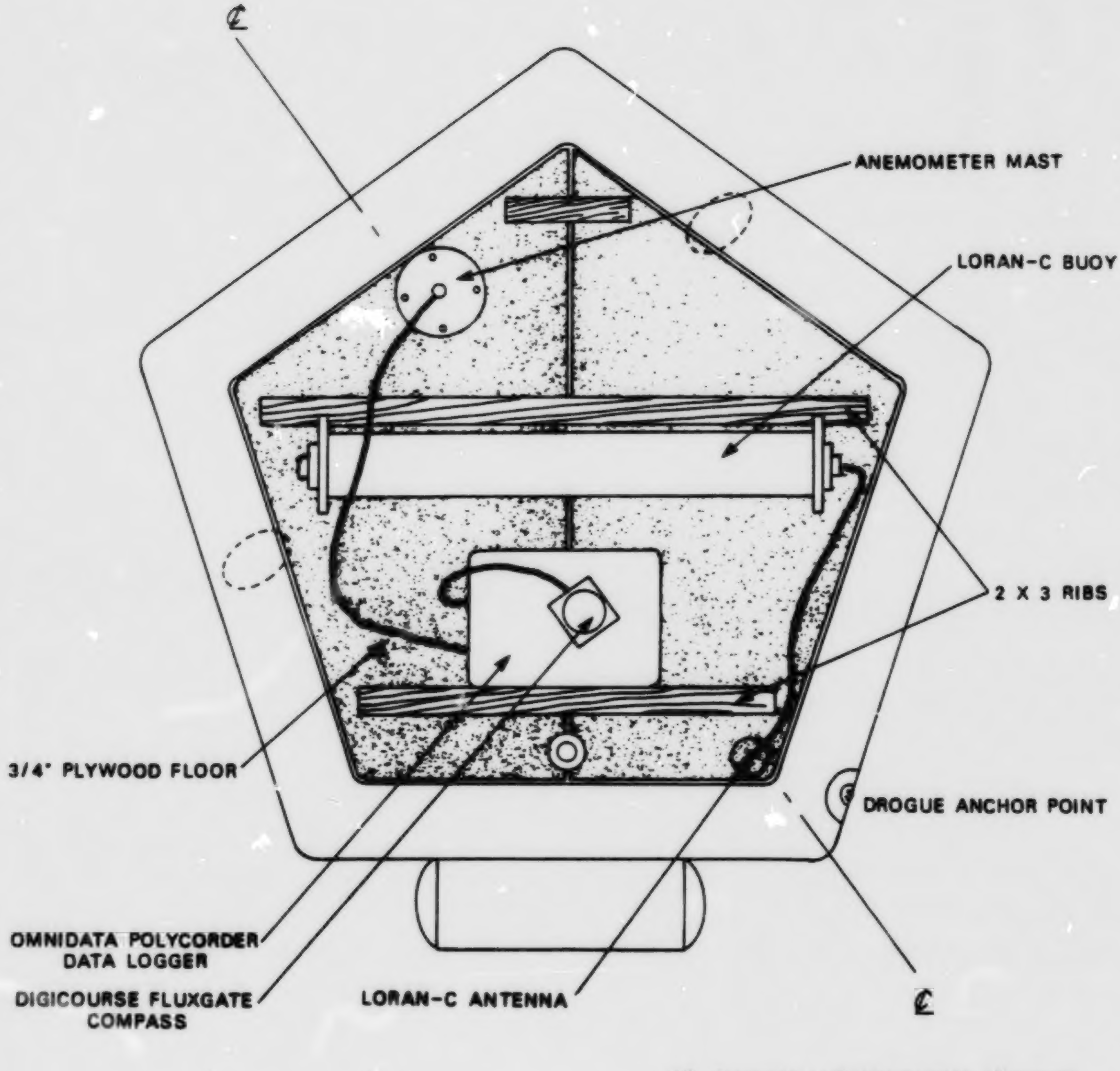


FIGURE 4 Beaufort 4 – Person Life Raft (side view)



NB. Compass and anemometer alignment
reference to center line

FIGURE 5 Life Raft Instrumentation Arrangement

The drifting buoys measured the current in the upper 1 m of the water column. These were compared with drift cards that had zero freeboard and subsequent adjustments were made to make the drift characteristics of the buoy similar to that of the zero drift card. This was accomplished by ballasting the buoys to reduce freeboard and adding fins to increase the ratio of the submerged area to the exposed areas thus minimizing leeway. A profile of a drifting buoy is shown (Figure 6).

3.6 Moored Instrumentation

A Datawell Waverider buoy was deployed on a single point mooring system in position 49° 50.0'N latitude and 54° 50.0'W longitude in the experiment area. The water depth at the mooring location was 360 m. A raised bottom mooring with a 2:1 scope above the sub-surface floats was employed. The mooring arrangement is illustrated (Figure 7). The mooring was successfully deployed on July 23, 1989 and fully recovered on September 15, 1989. The vessel's crane was used to assist in the deployment of the mooring while both the crane and towing winch were used during the recovery operation. The wave measuring buoy functioned properly throughout the full period of deployment.

3.7 Life Raft Deployment/Recovery Equipment

This device consisted of heavy netting stretched across a rectangular frame fabricated from 2"x2" square tubing. The four corners of the frame were suspended by slings from a spreader and bridle which was handled by the ships crane. After some experience the system proved to be quite adequate for deploying and retrieving a fully loaded instrumented life raft in winds up to 25 knots. An illustration of this system is shown (Figure 8).

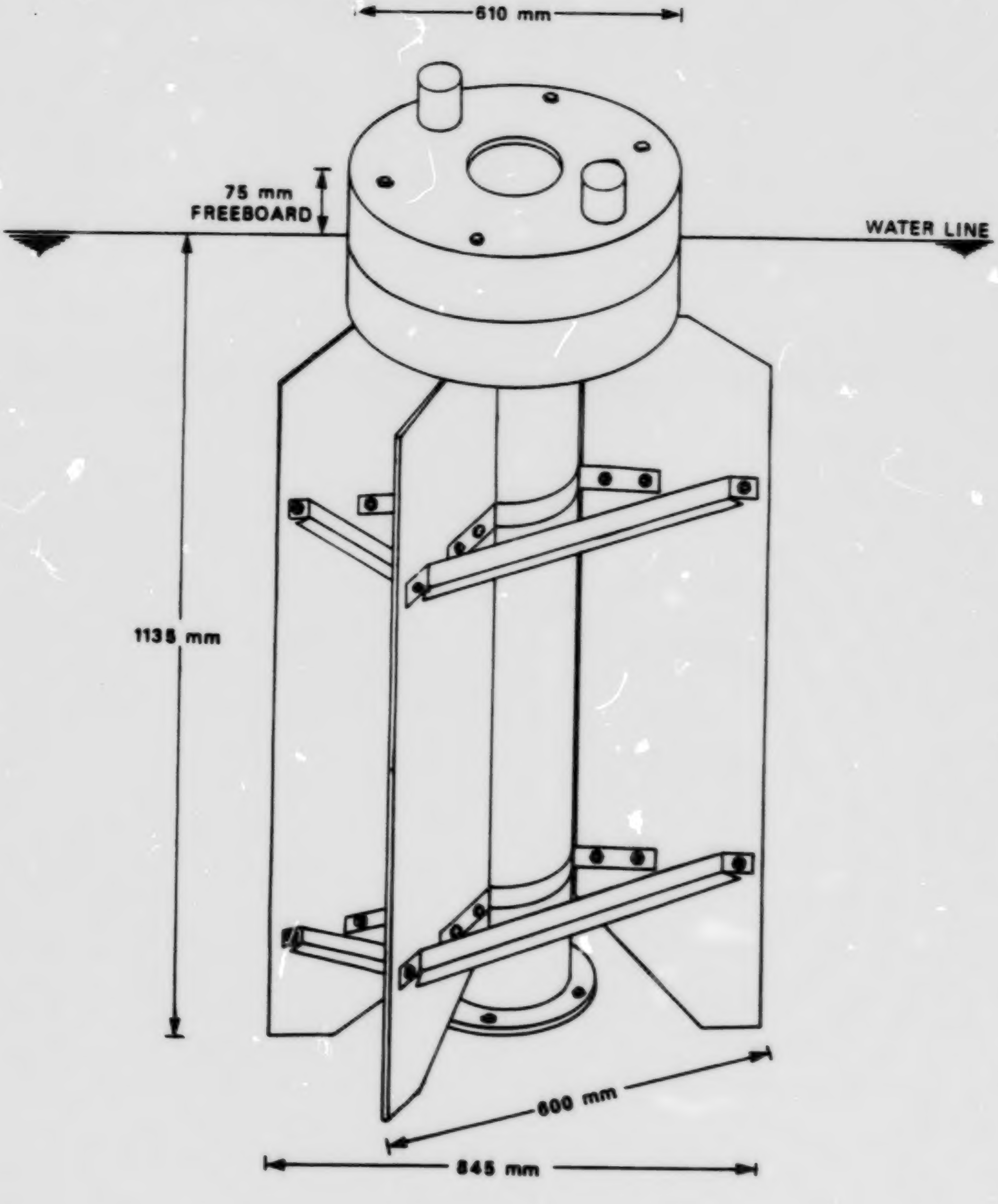


FIGURE 6 Loran – C Drifter Buoy

NOTES : 1. – S.S. Stainless Steel
2. Scope 2 : 1 above subsurface float
3. All powerbraid sections terminated in nylon thimbles
4. All S.S. Shackles secured
5. m – metres

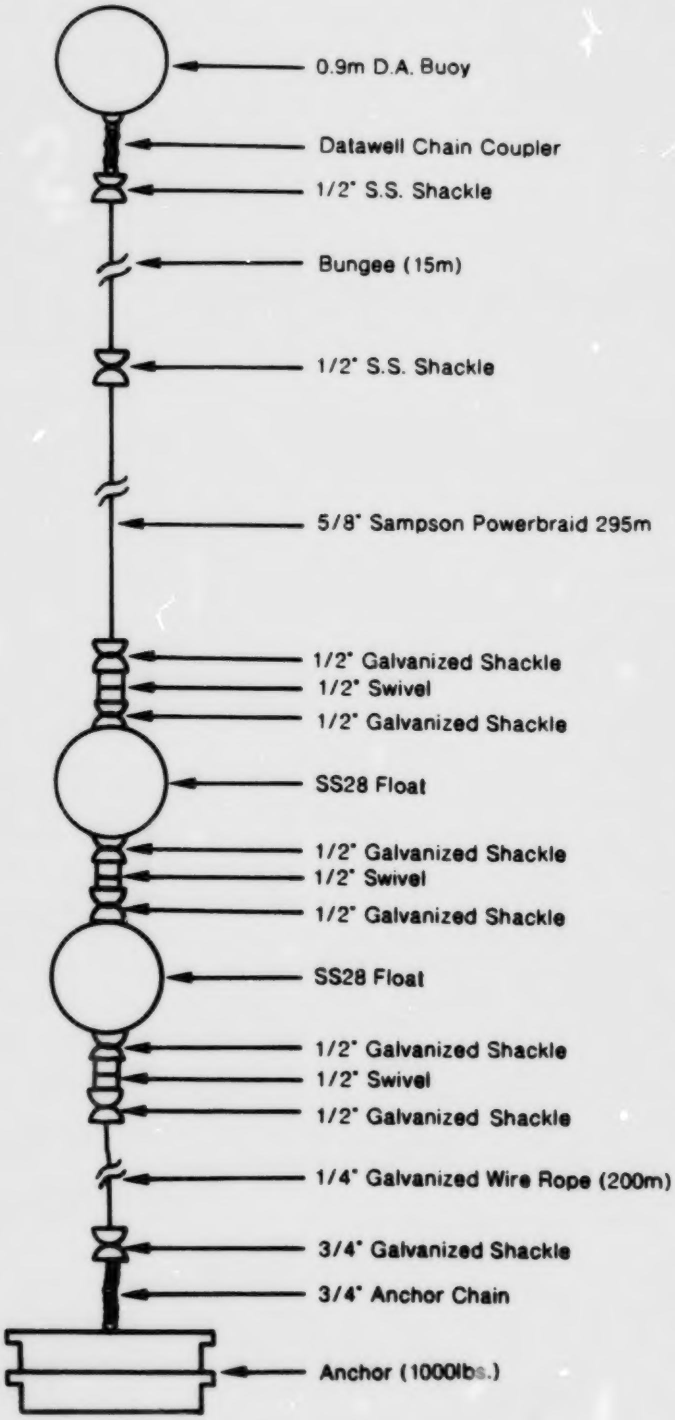


FIGURE 7 Waverider Buoy Mooring Arrangement

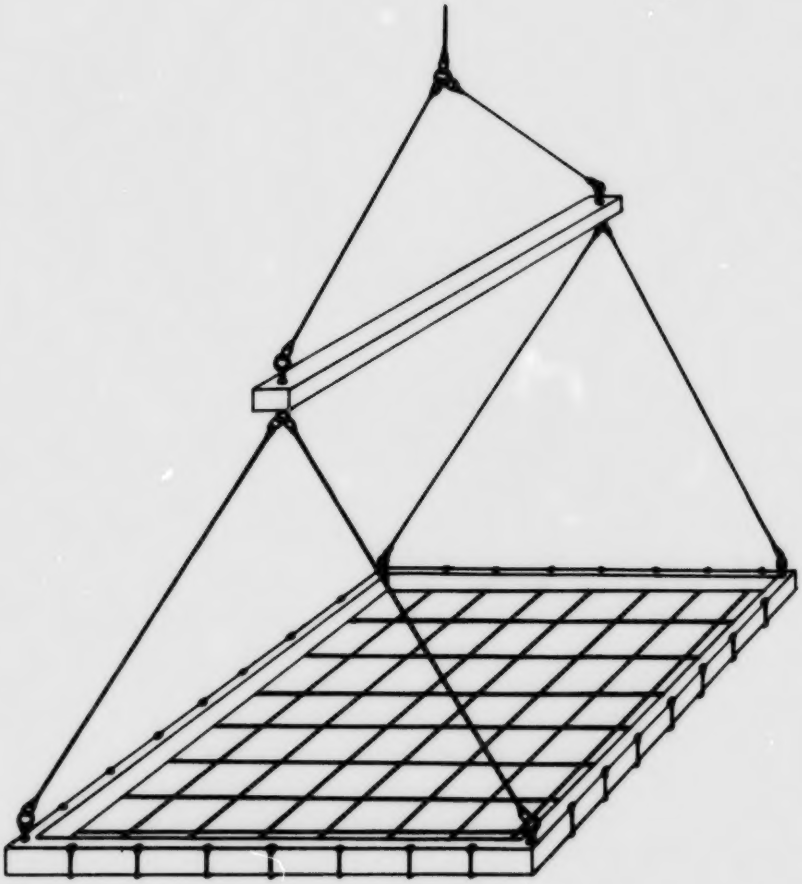


FIGURE 8 Life Raft Deployment / Retrieval Apparatus

4. DATA REDUCTION

The raw data collected in the field included the following:

a. position data for the life raft;
b. position data for the current drifters;
c. compass headings for the life raft;
d. relative wind at the life raft;
e. life raft configurations;
f. significant combined wave height;
g. wind at the monitoring vessel.

The position data used for the life raft and current drifters comprised of the raw time differences (TD's) for 5 minute intervals which was downloaded from the individual LORAN-C units. This data was edited to include only the positions during which the above objects were free floating and to remove any obvious spikes. Life raft drift and current velocity vectors for 5 minute intervals were derived from the raw TD's and individual drift tracks were reconstructed from the resulting vectors. The tracks were then viewed for quality and any unrealistic deviations removed. During this process it was observed that there was no significant difference in the current drifter tracks and, therefore, it could be assumed that the current field was uniform. Thus the data reduction could then be simplified by making the current at the life raft similar to current measured at the closest drifter. The final step in processing the position data was to derive 5 minute leeway vectors for each run by subtracting the current vectors from the corresponding life raft drift vectors. As a final check the leeway track for each run was plotted superimposed upon the original drift tracks and viewed for any obvious errors.

The compass heading and the relative wind records for the life raft were viewed and edited to include only the data during which the life raft was free drifting and any obvious spikes in the data were removed. Corrections were applied to convert the compass headings to true headings, then the relative wind was converted to the true apparent wind relative to the current. The leeway, since it is very small compared to the wind vector, is ignored in the reduction of the wind data.

After the screening of the data was completed, all the records were collated according to run number and life raft configuration. All of the records for drift, current, wind, compass and waves were combined and matched exactly in date and time in order to produce plots of leeway speed and leeway angle as a function of wind speed.

5. ANALYSIS AND RESULTS

5.1 Introduction

The data base for the drogued 4 - person life raft consists of 565 data points collected in winds of 0 - 19 knots at the life raft and wave heights from 0.2 - 2.1 m. The data base for the undrogued life raft consists of 195 points collected in winds of 0 - 12 knots at the life raft and waves of 0.5 - 2.0 m.

For this discussion the corner of the life raft where the drogue attachment point is located is considered the bow of the life raft. A fore and aft centre line through the bow was used as the reference for aligning the compass and the anemometer. The lubbers line of the compass was referenced to the fore and aft line and the anemometer was located on the fore and aft line and zero referenced to the bow. The recorded relative wind directions were converted to true apparent wind directions after correcting the compass headings to true headings. Thus the true apparent wind relative to the current was used in the analysis.

The results are presented as plots of the two components of the leeway vector, leeway speed and leeway angle, against wind speed at the life raft. These results were separated into plots for combinations of drogued, undrogued, two persons aboard and four persons aboard in order to determine the effect of each variable on leeway. The influence of the variables, wave height and life raft orientation were also investigated. Leeway rates were determined from a best fit line through the final leeway speed data above the 5 knot wind speed threshold. This was a cubic spline fit that minimizes a linear combination of the sum of squares of the residuals of the fit and the integral of the square of the second derivative.

In the plots of the leeway components against wind speed, there is some scatter in the data which can be attributed partly to operational problems with the LORAN-C drifter buoys. It was observed during the experiment that the data set for the buoys used in the life raft was significantly cleaner than the records from the buoys in the water causing the current track to be less smooth than the life raft drift track.

In plots of relative wind and leeway angle versus wind speed, considerable scatter was observed in the lower wind range which can attributed to fluctuation in the wind direction and variance in the navigation. During low wind speeds the errors in navigation approach or become greater in magnitude than the expected leeway. There appears to be a threshold at a wind speed of about 5 knots where the scatter is suddenly reduced and a trend can be seen in the plot. The effect of these variances become less significant as wind speed increases.

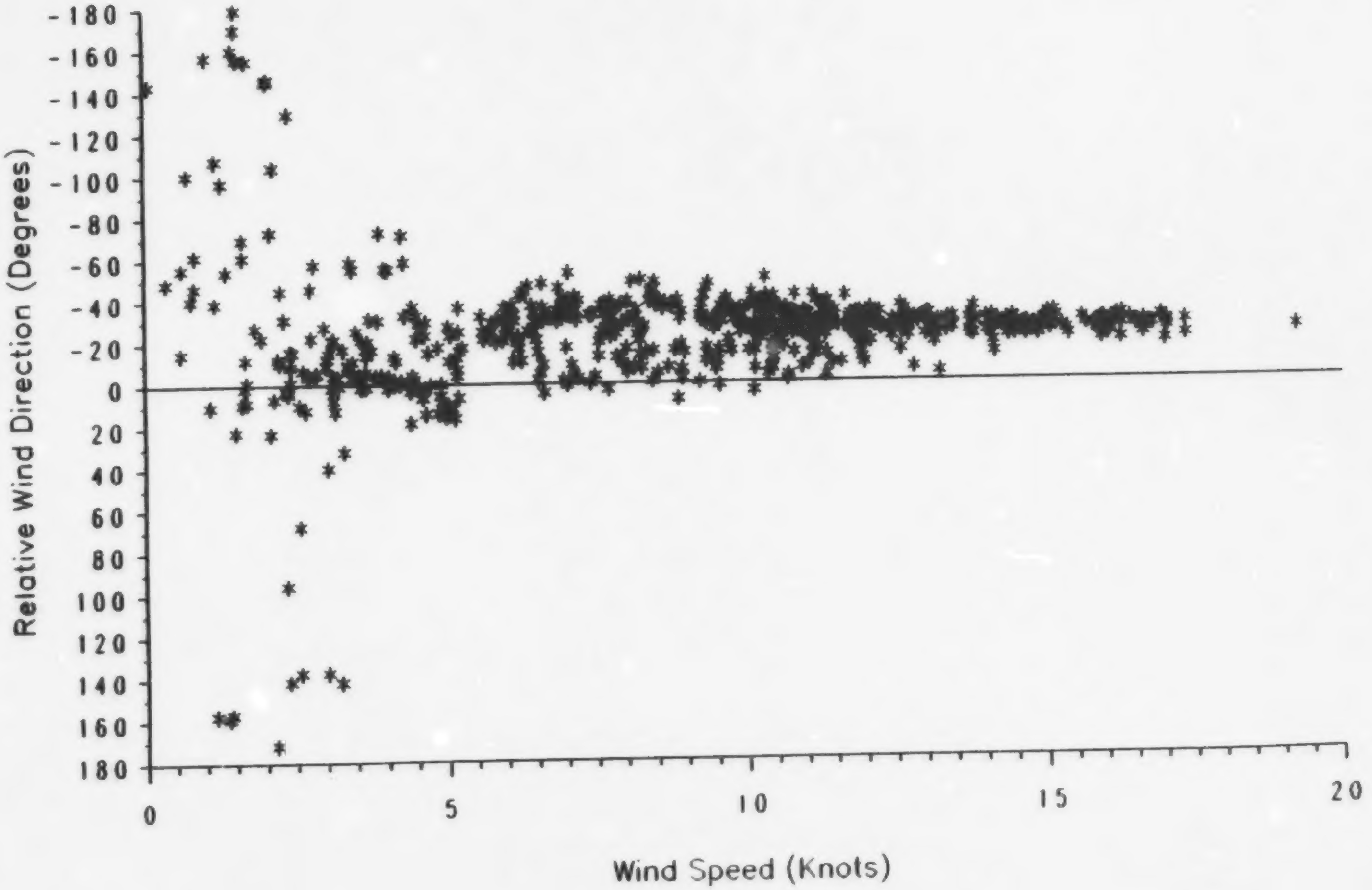
5.2 Life Raft Orientation

As an indicator of the life raft orientation, plots of relative wind direction versus wind speed were produced for life rafts with drogue and without drogue (Figures 9 and 10). In these figures the zero line refers to the life raft heading. The orientation of the drogued life raft for wind speeds greater than the five knot threshold showed a constant offset of -30°. The band width of the data points about the -30° constant narrowed from 60° at five knots to 20° at seventeen knots. In other words, the drogued life raft was found to lie with the wind 30° to the left of the drogue attachment point. The orientation of the undrogued life raft showed some scatter in winds up to ten knots but a denser band of the data showed a near linear rate of change of angle as the wind speed increased from 0 to 12 knots. The angle changed from -25° at 1 knot to -50° at 12 knots. This indicates that the undrogued raft will orientate itself with the wind on its port bow, similar to the drogued raft, but it will alter its heading causing this angle to increase as speed increases. The orientation of this particular life raft shows a near constant attitude that is likely attributed to the life raft shape. Consequently, there will be no effect from orientation upon leeway.

5.3 Leeway Angle for a 4-Person Beaufort Life Raft

The direction component of each leeway vector was matched in time with wind and plots of leeway angle versus wind speed were produced. The leeway angle is referenced to the down wind direction, with positive angles being to the right of down wind and negative angles to the left. In the analysis the effect on leeway angle of various life raft configurations, such a drogued or undrogued and two or four persons aboard, was investigated, along with the effect of wave height. The introduction of these variables showed no significant effect upon leeway angle. Therefore, all the data could be combined into one plot of leeway angle versus wind speed for a 4-person life raft.

The plot of leeway angle versus wind speed (Figure 11) shows a good distribution of data over the full range of winds recorded. There is a large scatter in the data below the 5 knot wind speed threshold where leeway speeds have been shown to be essentially zero and, therefore, no leeway angle. At the 5 knot threshold, the angles tend toward a positive leeway direction that is less than 90° either side of the wind. Below the 5 knot threshold, there is generally an equal distribution of data in the down wind and upwind direction, with the majority of data tending to the right of down wind. Beyond the 5 knot wind speed threshold the leeway angle falls within ±90° of down wind and the variance in the leeway angle decreases as wind speed increases. The data clearly shows that beyond a wind speed of 5 knots the leeway angle approaches a constant of 25° to the right of down wind as wind speed increases. The plot also indicates that for a 4 person life raft the leeway angle will vary from 90° either side of the wind at 5 knots, but as the wind approaches 15 knots the leeway angle will fall within a range of 0° to 50° to the right of down wind.



Leeway Experiment 1989
Relative Wind Direction vs Wind Speed for:
4-Person Life Raft Drogued

FIGURE 9

Leeway Experiment 1989

Relative Wind Direction vs Wind Speed for:
4-Person Life Raft Undrogued

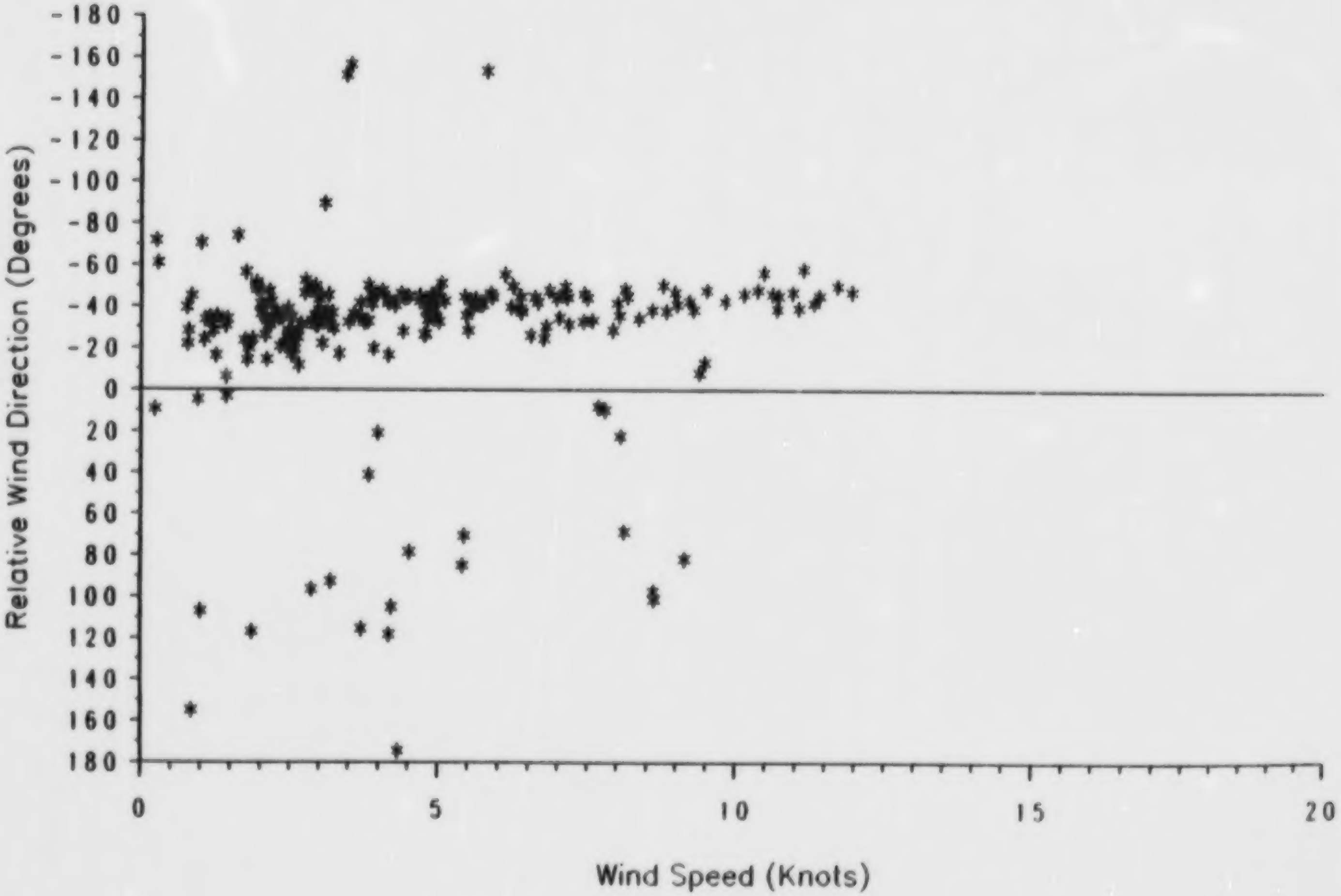


FIGURE 10

Leeway Experiment 1989

Leeway Angle vs Wind Speed for:
4-Person Life Raft

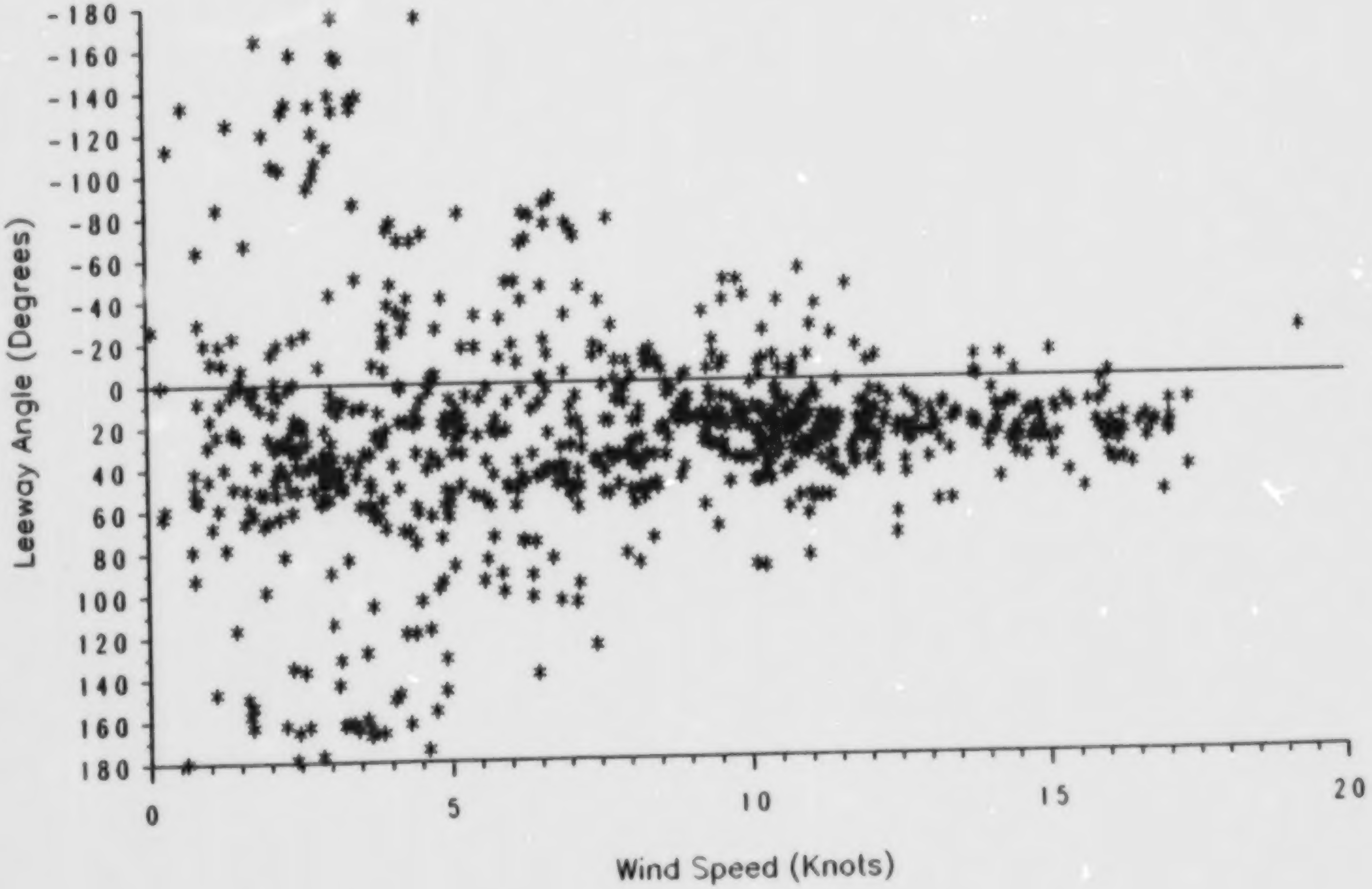


FIGURE 11

5.4 Leeway Speed for a 4-Person Beaufort Life Raft

The speed component of each leeway vector was matched in time with wind speed and plots of leeway speed versus wind speed for various life raft configurations were produced. The results show a significant difference between the leeway speeds for a drogued and undrogued life raft. Increasing the life raft ballast from a simulation of two persons to four persons aboard indicated no significant change in leeway speed for either a drogued or undrogued life raft of this size. The drogued and undrogued data was investigated with respect to significant wave heights. No significant effect on leeway speed was detected for the range of wave heights encountered. All of the leeway speed data was, therefore, condensed into two final plots for a drogued and an undrogued 4-person life raft.

5.4.1 Leeway Speed with Drogue

In this plot (Figure 12), there is a good distribution of data points over the range of winds recorded and it becomes immediately clear that there is a definite trend in the data pattern. A best fit line data was applied to the data above the 5 knot threshold and extended to the origin. Therefore, for the environmental conditions encountered, the leeway speed of this life raft can be read directly from this curve or determined from the following equations:

Leeway speed = 0.0150 (wind speed) for wind speed <5 knots

Leeway speed = 0.0338 (wind speed)$-$0.1 for wind speed ≥ 5 knots

5.4.2 Leeway Speed without Drogue

In this plot (Figure 13), there is a poor distribution of data over the range of winds recorded, which may be partially due to the fact that there is 65% less data than for the drogued life raft. There is a larger concentration of data for winds below the 5 knot threshold, an area in which the data is unreliable, but a definite trend in data distribution becomes apparent for winds beyond the 5 knot threshold. A best fit line was applied to the data above the 5 knot threshold and extended to the origin. Therefore, in the environmental conditions encountered, the leeway speed for a 4-person Beaufort life raft without drogue can be determined directly from this curve or from the following equations:

Leeway speed = 0.0175 (wind speed) for wind speed < 5 knots

Leeway speed = 0.0471 (wind speed) $-$ 0.1375 for wind speed ≥ 5 knots

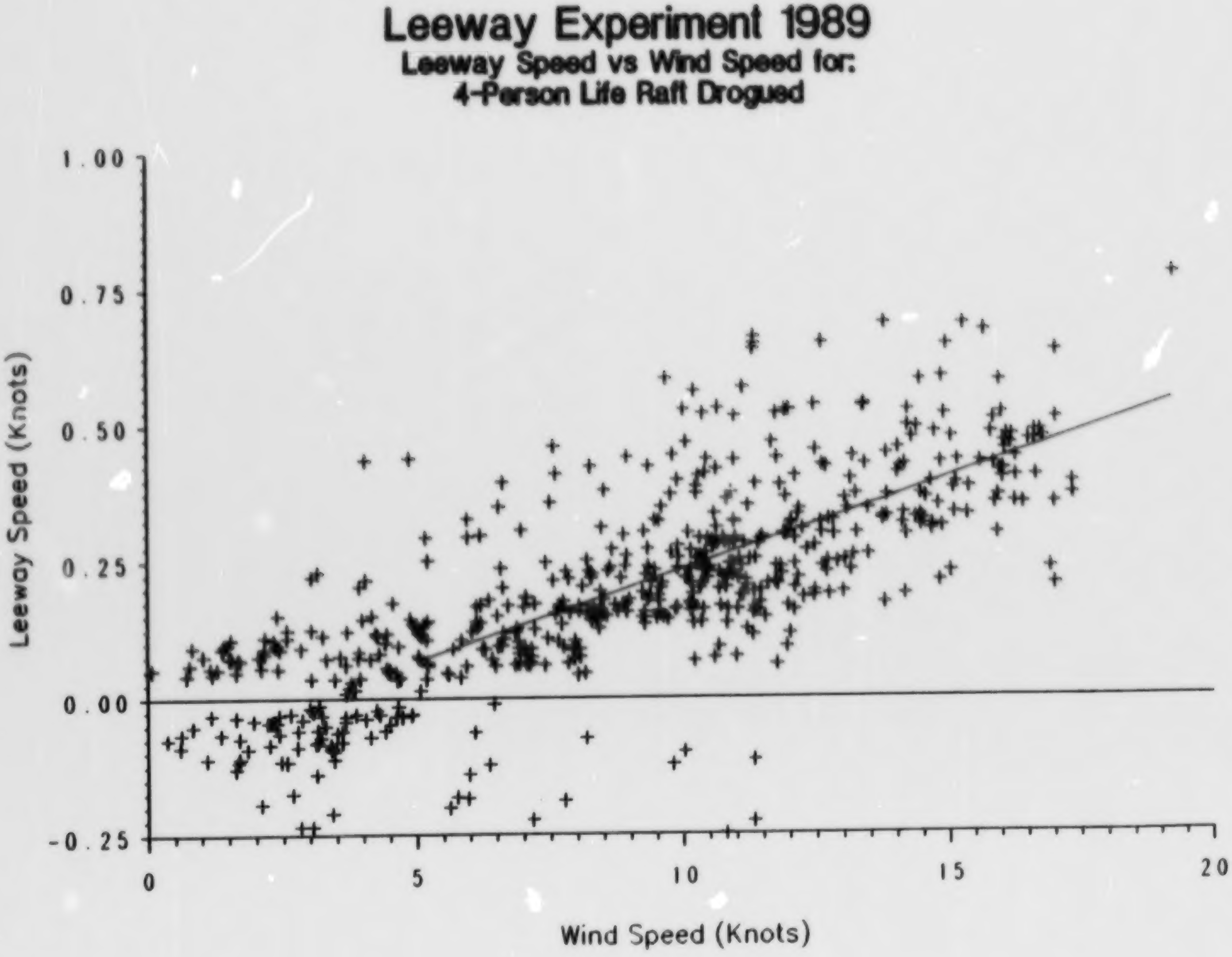

Leeway Experiment 1989
Leeway Speed vs Wind Speed for:
4-Person Life Raft Drogued

FIGURE 12

Leeway Experiment 1989
Leeway Speed vs Wind Speed for:
4-Person Life Raft Undrogued

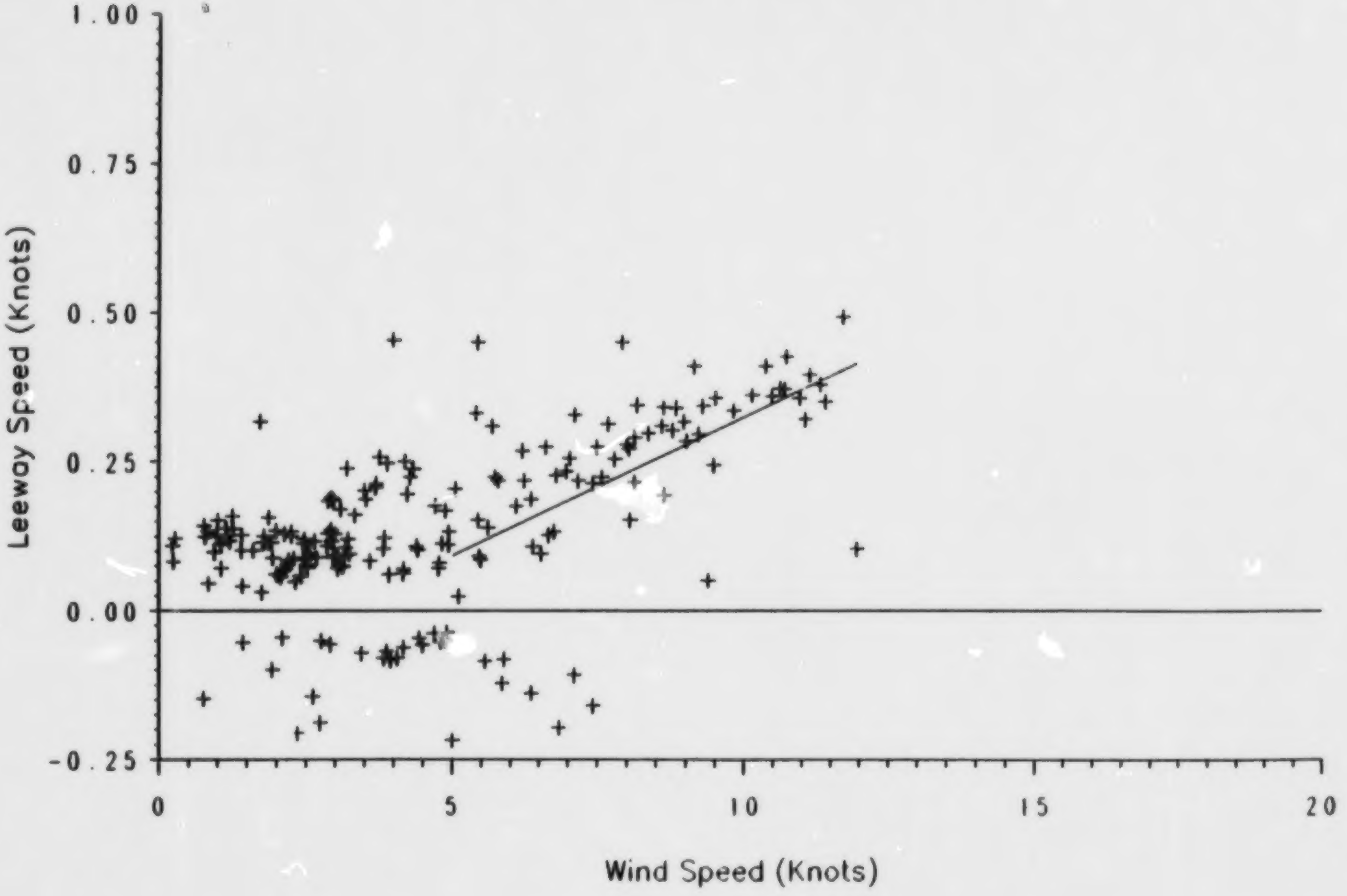


FIGURE 13

5.5 Wind Speed

The wind speed at the monitoring ship was measured every half hour at an elevation of 12.9 m above sea level. The wind at the life raft was measured relative to the life raft drift at an elevation of 1.6 m above sea level. The record from both locations were matched in time and a plot of life raft wind speed versus ship wind speed (Figure 14) was produced. A curve through the plotted data showed that the wind speed measured at the ship was 27.5% higher than the wind speed measured at the life raft.

Leeway Experiment 1989

Ship Wind Speed vs Raft Wind Speed for:

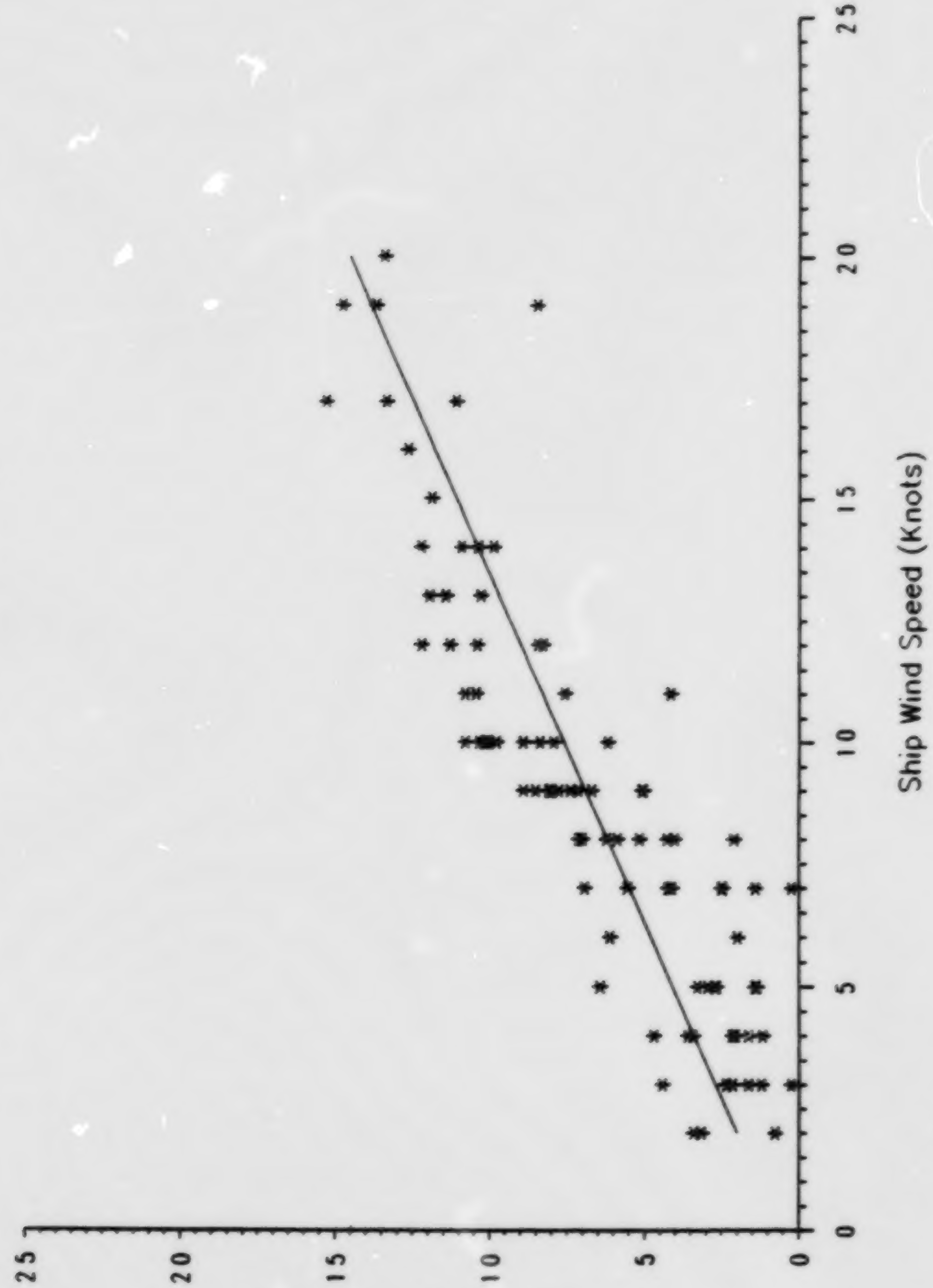


FIGURE 14

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Leeway for a 4 Person Beaufort Life Raft

This particular life raft is not symmetrical about a vertical axis. It is pentagon shaped with ballast chambers suspended under each of the five sides and its canopy support tube is offset from the centre of the raft. The ratio of the above surface to below surface profile is approximately 2:1. The floor was inflated during each drift run.

The angular component of the leeway vector approaches a mean leeway angle of 25° to the right of down wind. The variations in the leeway angle decreases from a range of -90° to $+90^{\circ}$ at the 5 knot wind speed threshold to a range of 0° to 50° at a wind speed of 19 knots for both a drogued and undrogued life raft. This near constant mean offset is most likely a result of the overall shape of the life raft. The drogue will induce a moment that tends to steer the life raft to maintain a near constant orientation to the wind. The undrogued life raft appears to be selfsteering by gradually changing its attitude as wind speed increases thereby sailing close to the mean leeway angle. It was also observed that the true leeway direction of the life raft was generally the reverse of the life raft heading. The National SAR Manual gives a general leeway angle in the range of 35° either side of down wind, for rubber rafts. This differs from the leeway angle of the test life raft which when stated in comparable terms is 25° either side of a 25° mean leeway angle.

The speed component of leeway is described by the following equations:

Drogued

Leeway Speed = 0.0150 (Wind Speed) for Wind Speed < 5 knots

Leeway Speed = 0.0338 (Wind Speed) -0.1 for Wind Speed ≥ 5 knots

Undrogued

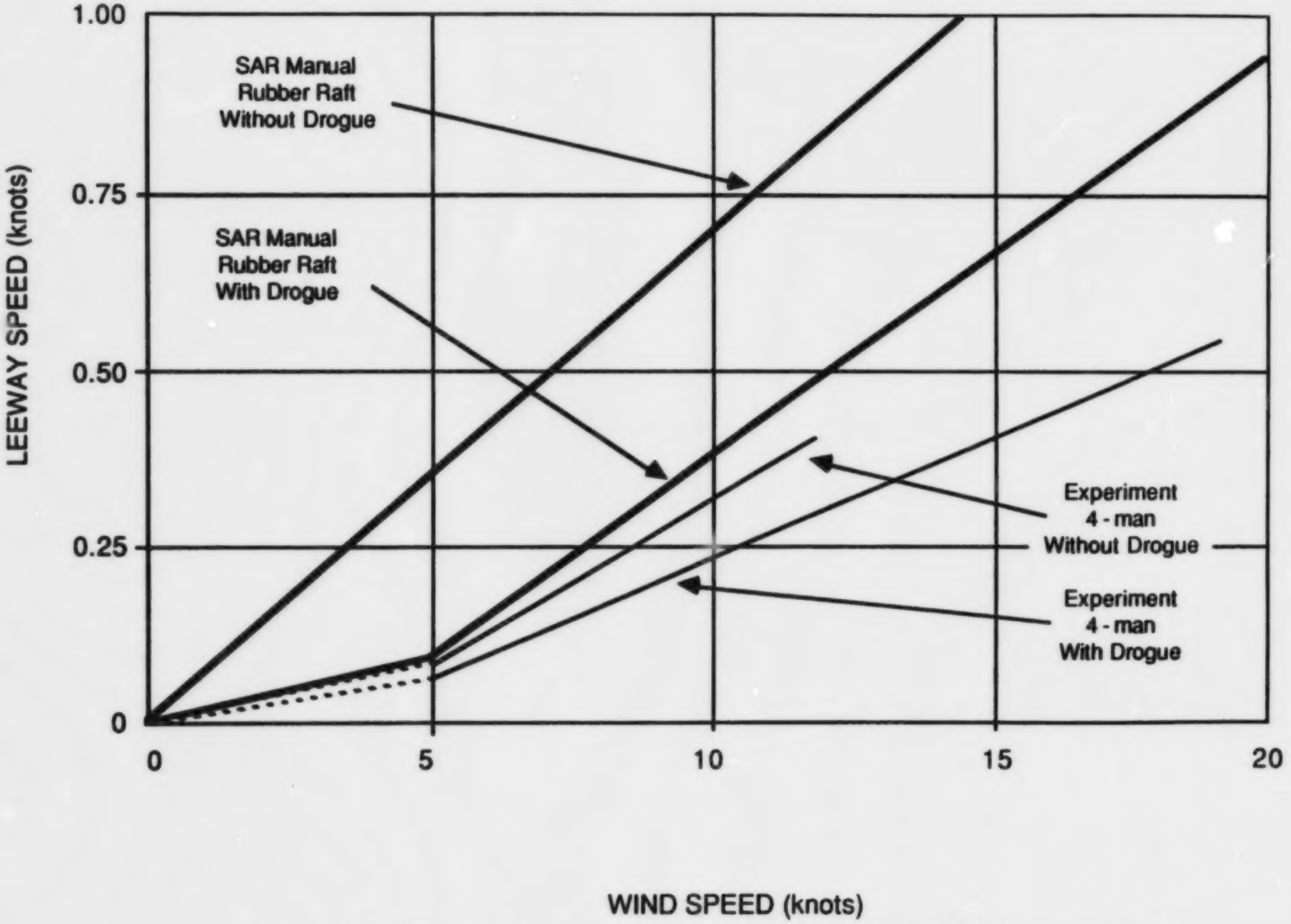
Leeway Speed = 0.0175 (Wind Speed) for Wind Speed < 5 knots

Leeway Speed = 0.0471 (Wind Speed)-0.1375 for Wind Speed ≥ 5 knots

The wind speed is the measured speed at the life raft relative to the current.

The leeway speed can also be read directly from the graph of leeway speed versus wind speed (Figure 15). This graph also shows a direct comparison with the guidance material from the National SAR Manual. The leeway rates for both the drogued and undrogued test life raft are

FIGURE 15



COMPARISON OF NATIONAL SAR MANUAL AND EXPERIMENT
FOR LEEWAY SPEED vs WIND SPEED

considerably less than those shown in the SAR manual. The attachment of the drogue to the test life raft increases the resistive underwater profile by approximately 25% and decreases the leeway rate by about 27%.

It is recommended that the leeway results from the experiment be considered as supplement to existing SAR guidance. The results should be used as a lower limit for leeway guidance, particularly for life rafts of similar overall shape and ratio of above surface to below surface profile as the 4-person test life raft, over the range of environmental conditions encountered during the experiment.

6.2 Wind Speed

During the experiment, the wind speed was measured at the life raft and at the ship. The anemometer heights were 1.6 m on the raft and 12.3 m on the ship. The wind speed was an average of 27.5% higher at the ship.

6.3 Methodology

The development of a detailed methodology for conducting leeway experiments in the Canadian offshore environment was one of the primary objectives of this experiment. The methodology has been proven by the successful outcome of this experiment plus a considerable amount of valuable experience was gained in the process.

6.4 Research Platform

The CCGS "Hood" proved to be adequate as a research platform for this experiment. The major constraints that could effect future experiments is the limited deck space and lifting capacity for handling larger heavy laden life rafts. Aside from this, she is particularly well suited for the deployment and retrieval of current drifters and as a monitoring vessel. Although she is not capable of handling larger life rafts, it may be possible for her to continue to assist in future experiments for determining the leeway of small boats. Various craft, ranging from small open boats to longliners, life boats and life capsules could be towed to the test site. In order to test larger life rafts, the utilization of a buoy tender is recommended since such a vessel would have sufficient lifting capacity and deck space. Also with a larger and more stable vessel such as a buoy tender it would be possible to collect data in higher wind and sea conditions.

6.5 Experiment Location

The experiment area in Notre Dame Bay turned out to be a well-chosen location mainly because the current regime in the area was discovered to be relatively uniform. The uniformity of the current regime was readily noticed by Mr. Art Allen, an Oceanographer with USCG, during his visit to the experiment site. Working in a uniform current regime greatly simplified the process of determining the current vector at the life raft.

6.6 LORAN-C Buoys

During the data processing, it was observed that the data from the LORAN-C current drifters was beginning to deteriorate in later part of the experiment. This could have been the result of repeated flexing of the electronics chassis within the buoy which may have caused intermittent electronic problems. Movement in the chassis is quite obvious when the top end is removed from the buoy. This may be easily remedied with modification of the chassis.

It was also observed, during the data processing, that the LORAN-C buoys used in the life raft produced a cleaner data set than the buoys used for current drifters. An improvement in the data was clearly seen when a buoy that was used as a current drifter was placed in the life raft. This effect may be due to the fact that the buoy in the raft, along with its antenna is more protected than the drifter buoy which is generally awash.

6.7 SAR Objects to be Tested in Future Leeway Experiments

It is recommended for the next leeway experiment that a small boat, common to the Atlantic coastal region, be tested; for example a 20 - 30 ft open fishing craft. A second common SAR object that should be tested is an enclosed life boat of the type used on ships and offshore drilling platforms. These craft could be fitted with instrumentation and towed the 10 nmi to and from the site for the experiment. It is also recommended that another type of 4-person life craft be tested for comparison with the results contained in this report. The leeway for larger life rafts (i.e., 10 person, 25 person) also needs to be investigated but the services of a buoy tender would be required to handle deployment and recovery. Also, larger life rafts should be of the davit launched type to facilitate easier handling.

6.8 Life Raft Design

The recovery and deployment of the test life raft, especially when fully loaded with ballast and instrumentations, was a critical and difficult part of the field operations. In a survival situation, the rescue of survivors from a larger standard marine life raft or attempting to recover a life raft with survivors would certainly be much more difficult than our experience. If life rafts were designed with ease of rescue or recovery in mind, similar to a davit launched raft for example, it may help facilitate a more efficient rescue operation.

Leeway should also be a consideration in the design of marine life raft. Life rafts that are symmetrical about a vertical axis would be expected to have zero leeway angle. In addition, if the ratio of the above surface to below surface profile of a life raft were reduced by modifying the ballast chambers, the leeway rate would be expected to be reduced. These two considerations could reduce leeway and, therefore, reduce the search area.

6.9 New Technology

As was recommended by the Nash-Wilcox report of January 1989, the electromagnetic current meter should be investigated for possible use in future leeway experiments. The ability to measure leeway directly by attaching a current meter to the test craft will allow data to be collected in high winds and sea states. In addition, it is felt that this new method will greatly improve the efficiency of leeway data collection for various SAR objects.

REFERENCES

1. Chapline, W.E., 1960. "Estimating the Drift of Distressed Small Craft." Coast Guard Alumni Association Bulletin", U.S. Coast Guard Academy, New London, CT. Vol. 22, No. 2, March-April 1960, p. 39-42.

2. Dawe, B.R., D. Finlayson, and D. Bryant, 1988. Search and Rescue Target Detection Experiment - Canso Bank, 1987. Transportation Development Centre, Transport Canada, Montreal. Report No. TP9475E.

3. Department of National Defence and Canadian Coast Guard, 1985. National Search and Rescue Manual. Department of National Defence and the Canadian Coast Guard, B-GA-209-001/FB-001, Ottawa.

4. Hufford, G.L., and S. Broida, 1974. "Determination of Small Craft Leeway." U.S. Coast Guard Research and Development Center Report No. 39/74, December 1974.

5. Morgan, c.W., 1978. "Seven-Man Life Raft Leeway Study." U.S. Coast Guard Oceanographic Unit Technical Report 78-1, Washington, D.C.

6. Morgan, C.W., S.E. Brown, and R.C. Murrell, 1977. "Experiments in Small Craft Leeway." U.S. coast Guard Oceanographic Unit Technical Report 77-2, Washington, D.C.

7. Murphy, D.L., Nash L., D.F. Lundy and Omer S.R., 1982. "An Evaluation of SARP Drift Prediction Using Satellite-Tracked Drift Buoys." U.S. Coast Guard Research and Development Center, Rep. No. CG-D-05-83 Washington, D.C.

8. Nash, L., and J. Willcox, 1989. Spring 1985 Leeway Experiment. U.S. Department of Transportation United States Coast Guard, Office of Engineering and Development Washington, D.C. Final Report.

9. Nash, L., and J. Willcox, 1985. Summer 1983 Leeway Drift Experiment. U.S. Department of Transportation United States Coast Guard, Office of Research and Development Washington, Rep. No. CG-D-85.

10. Osmer, S.R., N.C. Edwards, Jr., and A.L. Breiter, 1982. "An Evaluation of Life Raft Leeway, February 1982". U.S. Coast Guard Report No. CG-D-10-82 (unpublished).

11. Pingree, F. deW., 1984. "Forethoughts on Rubber Rafts". Woods Hole Oceanographic Institution. 26 pp.

12. Scobie, R.W., and D.L. Thompson, 1979. "Life Raft Study, February 1978". U.S. Coast Guard Oceanographic Unit Technical Report 79-1, Washington, D.C.

APPENDIX A

DETAILED EXPERIMENT PLAN

FIELD PLAN TO CONDUCT AN EXPERIMENT TO DERIVE LEEWAY AND DRIFT RATES FOR COMMON SEARCH AND RESCUE OBJECTS

NOTRE DAME BAY, NEWFOUNDLAND
SUMMER 1989

Submitted to: Transportation Development Centre
and
Canadian Coast Guard
Submitted by: NORDCO Limited
Ref. No: 289-88G.001
Date: May 26, 1989

TABLE OF CONTENTS

1. INTRODUCTION A1

2. BACKGROUND A3

3. DETAILED EXPERIMENT PLAN A6
   - 3.1 Experiment Objectives A6
   - 3.2 Experiment Time Frame A6
   - 3.3 Experiment Location A6
   - 3.4 Relevant Vessel Characteristics A9
   - 3.5 Participants A10
   - 3.6 Instrumentation and Equipment A11
     - 3.6.1 Moored Instrumentation A11
     - 3.6.2 Free Drifting Instrumentation and Equipment A11
     - 3.6.3 Shipboard Instrumentation and Equipment A13
   - 3.7 Schedule A15
   - 3.8 Experiment and Methodology A17
     - 3.8.1 Data Collection A17
     - 3.8.2 Wave Buoy Mooring Deployment and Recovery A19
     - 3.8.3 Drift Run Scenario A19

REFERENCES A22

1. INTRODUCTION

In December 1988, NORDCO Limited was awarded a contract by Supply and Services Canada on behalf of the Transportation Development Centre (TDC), Transport Canada, to conduct a search and rescue (SAR) object leeway and drift experiment. The work of the current contract is the first of a series of leeway and drift experiments to be conducted over a multi-year period. The results of the project are expected to be used to update SAR planning guidance material provided in the National Search and Rescue Manual (Department of National Defence and Canadian Coast Guard, 1985). The expected benefit of the work is an improvement of the overall effectiveness of marine SAR operations.

This documents describes the field plan to conduct the first leeway and drift experiment to be carried out in Canadian waters. The experiment can, however, be considered to be an extension on previous SAR detection experiments conducted by NORDCO Limited on behalf of the TDC and the Canadian Coast Guard (CCG) each year since 1986 (eg., Dave et al., 1988).

To date, the United States Coast Guard (USCG) has conducted a number of leeway experiments over the last number of years. Significant differences have been found between experimental observations of both leeway and drift and those predicted using operational SAR planning practice. More accurate prediction of leeway and drift vectors will enable SAR controllers to concentrate search resources in smaller areas, with an attendant increase in probability of locating and rescuing survivors of a mishap at sea. The anticipated efficiency improvement will also result in a substantial savings in SAR mission costs.

This document constitutes the detailed experiment field plan to be carried out under the terms of the present Supply and Services Canada contract. Preparatory work, which began in January 1989, will continue into June when an initial three day field trial will be undertaken. Upon completion of final preparations, the experiment will be conducted in two parts during the summer of 1989 in Notre Dame Bay, Newfoundland, with the support and cooperation of the Newfoundland Region of the CCG. Operational and logistical support for the experiment is being managed by Captain William Nash, Regional Manager Search and Rescue, Newfoundland Region.

The data analysis will be done during the autumn of 1989; the final report on the work will be prepared during the winter of 1989/90 for delivery to TDC on March 15, 1990.

Prior to presenting the details of the field plan, a summary of previous work will be given.

2. BACKGROUND

A prediction of search object drift requires a knowledge of the mean or residual current (sea current), tidal current velocities, the local wind driven current (computed using the local wind history and predicted wind velocities), miscellaneous currents such as longshore currents where applicable, wave induced drift (Stokes transport), and the leeway velocity of the particular search object. Leeway is the component of the total drift caused by the action of the wind on the exposed area of the drifting object. Leeway speed is the speed of the object caused by the wind alone; leeway angle is the angle off downwind that the object will sail. In the past, certain investigators have included the wave induced drift along with the wind effects in their definition of leeway (eg., Chapline, 1960). The following paragraphs provide a review of previous leeway experiments.

One of the earliest life raft drift investigations to be undertaken was conducted in 1943-44 by the Woods Hole Oceanographic Institute (Pingree, 1944). One- to five-person inflatable rubber life rafts were used in the experiments which were conducted in winds up to 20 knots in three locations: Buzzards Bay, Massachusettes; Gulf of Mexico off Florida; and in the open Atlantic Ocean of the northeast coast of the Bahama Islands. The results for drogued and undrogued life rafts of varying loadings indicate a considerable scatter in the drift rate as a function of wind speed.

In 1959, a leeway study was conducted off Hawaii by the USCG (Chapline, 1960). A wide variety of craft including light and moderate displacement cruisers, outboard runabouts, skiffs, an assortment of fishing vessels, moderate and heavy displacement sailing vessels, and surfboards were used in the experiments. The vessel types were classified into five groups and the leeway rate was given as a fixed percentage of the wind speed for each category. The leeway data were obtained in moderate to fresh winds (11 to 21 knots). Leeway angle was found to vary widely for the craft used; the leeway angle results, as discussed in the paper, are incomplete provide little useful guidance for a SAR operations.

Between 1969 and 1971 the USCG Oceanographic Unit conducted a series of leeway experiments (Morgan et al., 1977 and Morgan, 1978). Comparison of these results with those of Hufford and Broida (1974) show large differences between the derived wind speed versus leeway angle and speed relationships. Morgan (1978) reported that the leeway for a seven-person oblong raft without ballast was 35 degrees to the right of the wind for a 5 knot wind and near zero degrees for wind speeds above 10 knots.

Another leeway experiment was carried out by the USCG Oceanographic Unit in 1978 (Scobie and Thompson, 1979). Six-, twenty-, and twenty-five person life rafts, all with improved ballast systems were tested. One leeway speed equation encompassing all the life rafts was reported. The leeway angle was reported to be less than 30 degrees for 78% of the drift runs.

The USCG Research and Development Centre in Groton, Connecticut undertook a variety of leeway experiments between 1979 and 1981 (Osmer et al., 1982). A number of four- and six-person life rafts were used. Due to the scatter in the data, no conclusions were reached.

The latest work on leeway investigations was undertaken by Nash and Wilcox (1985) at the USCG Research and Development Center. A significant difference was found between the leeway of lightly ballasted life rafts and more heavily ballasted life rafts, with the leeway speed of the latter being much slower. The leeway direction of the lightly ballasted life rafts was dependent on the orientation of the life raft, while the heavily ballasted units drifted directly downwind. During the experiment the wind speeds ranged from 2 to 11 knots with waves of zero to 2 feet. Once again, there was a great deal of scatter in the data.

Regarding accuracy of drift predictions, a series of experiments was conducted by the USCG Research and Development Center between 1979 and 1981 to evaluate the accuracy of drift predictions using the US Computerized Search and Rescue Planning (SARP) system. Historical current information provided the current data base. Of the 680 drift predictions that were evaluated, the drift object position was within the SARP predicted area in only 41 cases (6%).

It is apparent that further work is required to improve SAR drift prediction capability. The proposed experiment is expected to help clarify leeway rates and directions for four- and six-person life rafts. At the present time the leeway rates provided by Chapline (1960) and those reported by Scobie and Thompson (1979) serve as the primary leeway speed guidance given in the National Search and Rescue Manual (Department of National Defence and Canadian Coast Guard, 1985).

3. DETAILED EXPERIMENT PLAN

3.1 Experiment Objectives

The primary objective of this experiment is to obtain quantitative leeway and drift information for a variety of common SAR objects under a wide range of environmental conditions. For this initial field experiment, the SAR objects will be restricted to four- and six-person inflatable life rafts since they are commonly carried on board small fishing, commercial, and pleasure craft and because they are known to experience relatively high leeway speeds. As this project is to be the first of a series of similar experiments, the work will serve as a pilot wherein the approach and technology used will be evaluated for future work.

3.2 Experiment Time Frame

The experiment is to be conducted in two parts, each part of two weeks duration, during the summer of 1989. Prior to conducting the experiment, a three day field trial will be conducted in June 1989. The first phase of the field work will be conducted in July, while the second part will be done in August. A detailed schedule is provided in sub-section 3.7.

3.3 Experiment Location

The selection of an experiment area is largely dependent on the availability of a suitable vessel from which to conduct the work. The CCG Newfoundland Region has offered to support the project by providing a vessel from which to conduct the leeway investigation. Captain William Nash, Regional Manager Search and Rescue, Newfoundland Region suggested that the CCG SAR Cutter "Hood" might be an appropriate vessel from which to carry out the experiment. After reviewing the general arrangement of the vessel and investigating characteristics of its area of operations, it was decided to conduct the experiment in Notre Dame Bay, Newfoundland (see Figure 1) during the summer months of 1989 using the CCG SAR Cutter "Hood". The base of operations will be

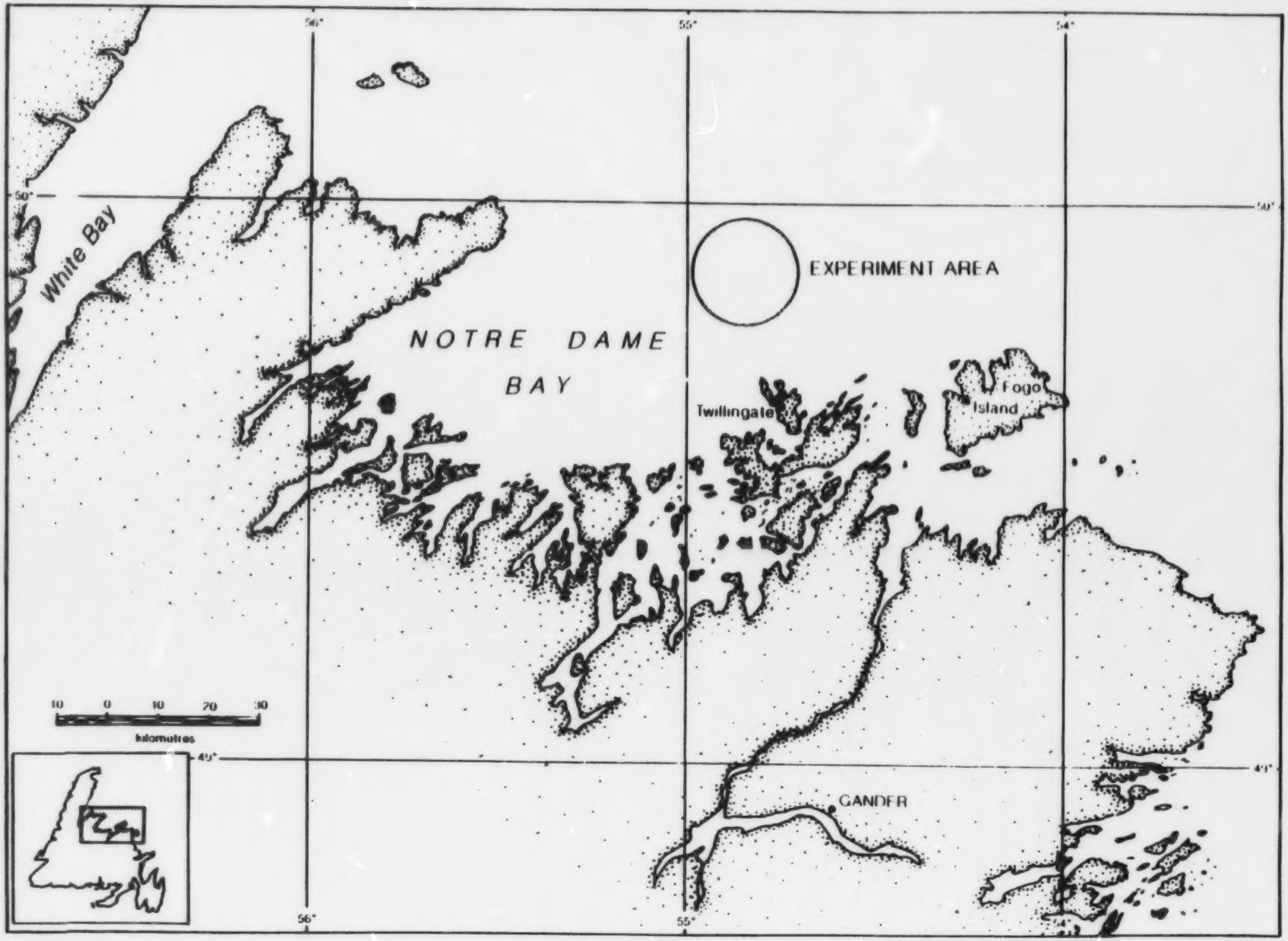


FIGURE 1 - Experiment Location

the town of Twillingate on Twillingate Island. The intention is to conduct the drift/leeway experiment in a circular area of approximately 6 nautical miles radius, centred on a point (49°52′N, 54°50′W) approximately 11.5 nautical miles north-northwest of the entrance of Twillingate Harbour.

In summary the Notre Dame Bay area was selected for the following reasons:

1. Twillingate, in Notre Dame Bay, is the base of operations for the CCG Cutter "Hood" during the summer months.
2. The LORAN-C coverage in the area is believed to be adequate for drift object position determinations, with time differences available from both the East Coast LORAN-C chain (GRI 5930) and the Labrador Sea chain (GRI 7930).
3. The Coast Guard maintains a small operations base adjacent to the government wharf in Twillingate which has both office and warehouse space.
4. While little is known of the current regime, it is expected that a general set to the eastward will prevail and that local influences due to bathymetric features are unlikely to dominate since the water depth in the area is relatively deep (near 365 metres).
5. Fishing activity in the area has been reported to be light.
6. Other vessel traffic is expected to be light, minimizing interference.
7. Wind and sea conditions in Notre Dame Bay during the summer months are expected to be conducive to the running of this first Canadian leeway/drift experiment. The most frequent wind direction is from the southwest in both July and August, with winds from the south through west occurring approximately 60% to 65% of the time,

respectively. Light to moderate wind speeds are expected to prevail. In general, light seas can be expected which will facilitate equipment deployment and recovery procedures. Good visibilities are expected to prevail throughout the experimental period. Mean summertime temperatures are expected to be near 15 Celsius over the water in both July and August.

3.4 Relevant Vessel Characteristics

As stated in the previous sub-section, the research vessel to be utilized will be the CCG SAR Cutter "Hood". The CCG Cutter "Hood" is a dedicated SAR vessel which was recently commissioned. The overall length of the vessel is 24 metres (80 feet) and and is 7.6 metres (25 feet).

The after deck is equipped with a PM Autogru model number 13002M crane and an inflatable runabout. The crane, with a safe working load of 1400 Kg at 7.5 metre reach, is more then adequate to handle the ballasted life rafts. Deck space is minimal but adequate to facilitate the management and stowage of project equipment. Vessel freeboard is quite low, facilitating the handling of equipment over the side.

Immediately forward of the afterdeck is the survivor receiving area or first aid station. This area is equipped with a berth and several lockers above the berth. This space is sufficient to support project requirements for navigation equipment, wave measuring monitoring equipment, computer systems, and ancillary gear. Antenna leads and the anemometer signal cable can be led along the stairway to the bridge deck then, from there, to the monkey's island and the ships mast.

It is anticipated that one individual will be stationed in the wheelhouse during the experiment as an observer. There will, however, be no requirement for the installation of instrumentation in the wheelhouse.

The normal ships complement is seven officers and seamen. In addition to crew accommodation, the vessel has a "survivors" cabin which has 5 berths, a head, and a desk. The galley/mess facilities are adequate to handle project personnel in addition the the normal complement.

3.5 Participants

The leeway/drift field experiment will be conducted by the following NORDCO Limited personnel:

Duncan Finlayson, Project Manager
Reg Fitzgerald
John Russell

Prior to the field work, the above personnel can be reached at:

NORDCO Limited
P.O. Box 8833
St. John's, NF
A1B 3T2

Telephone: (709) 364-1200
Facsimile: (709) 364-3550

During the mobilization periods and during an initial three day field trial, one additional NORDCO Limited employee, an electronics technician, will be required to assist in the installation and testing of the instrumentation and equipment on board the vessel.

It is anticipated that one or two crew members will be required at times to assist in the deployment and recover of the life raft and the drifting buoys. It may be necessary to work from the inflatable runabout at times.

Certain individuals have indicated their interest in participating as observers during the initial field trials or during the experimental periods. Mr. Mike Kelly, Superintendent of SAR Research and Development, CCG Ottawa has indicated his intention to visit the CCG Cutter "Hood" during the August portion of the work. Either Captain Nash or Captain Penney of the Newfoundland Region is expected to visit the CCG Cutter "Hood" at some time during the field experiment. Other personnel from the Maritime and the Central Region of the CCG, and from the USCG R&D Center in Groton, Connecticut have also expressed an interest in visiting the CCG Cutter "Hood" during the initial field trials or the July experiment period. It is anticipated that their visits will be of short duration, and that there will be no more than two persons at any one time. Detailed information regarding these additional personnel will be made available to the Manager Search and Rescue, Newfoundland Region at the earliest opportunity.

3.6 Instrumentation and Equipment

3 6.1 Moored Instrumentation

A Datawell Waverider buoy will be deployed on a single point mooring system near the centre of the experimental area. The scope of the mooring will be 2:1 above the sub-surface float. Figure 2 illustrates the mooring arrangement. The water depth in the area is approximately 365 meters.

3.6.2 Free Drifting Instrumentation and Equipment

As stated in the sub-section 3.1, the drifting objects will be four- and six-person inflatable canopied life rafts. Two rafts, one of each size, have been outfitted for use during the experiment. Each raft is equipped with a plywood floor on which the instrumentation and ballast material will be mounted.

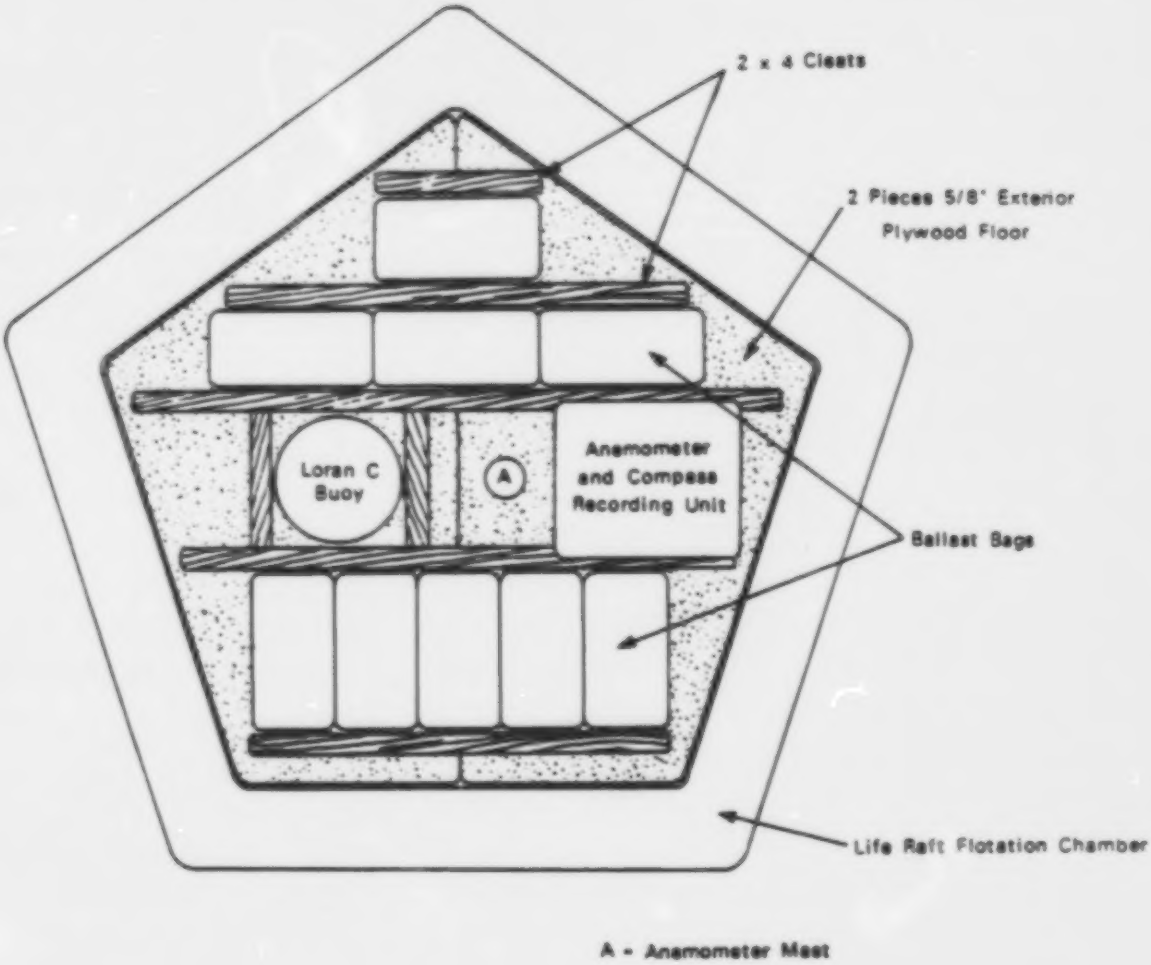

2 x 4 Cleats
2 Pieces 5/8" Exterior Plywood Floor
Loran C Buoy
A
Anemometer and Compass Recording Unit
Ballast Bags
Life Raft Flotation Chamber
A - Anemometer Mast

FIGURE 2 - Schematic of Life Raft Arrangement

The life raft instrumentation will include:

1. one Candel Industries Limited Sea Rover 3 LORAN-C buoy complete with a VHF transmitter;
2. one R.M. Young anemometer system;
3. a fluxgate magnetic compass unit; and,
4. a Omnidata Polycorder data logger.

The LORAN-C buoy will be secured to the plywood flooring and protrude through the observers hatch in the canopy. The anemometer sensor will be mounted on a 3.8 cm (1.5 inch) diameter aluminum pipe stand extending through a hole in the canopy. The sensor height will be approximately 1.5 metres above the sea surface. In addition to this instrumentation, the raft will be provided with ballast in the form of sand bags to simulate survivor loading. Figure 3 illustrates the life raft arrangement.

Tests will be conducted on drifting lift rafts with and without drogues with varying amounts of ballast. Both the four- and six-person units are equipped with water ballast bags secured to the bottom of the life raft.

The surface current field will be measured by tracking an array of Sea Rover 3 drifting buoys deployed in the waters surrounding the free drifting life raft. Three buoys will be available; equipped with a LORAN-C receiver and VHF telemetering system, they will be identical to the unit deployed in the life raft.

3.6.3 Shipboard Instrumentation and Equipment

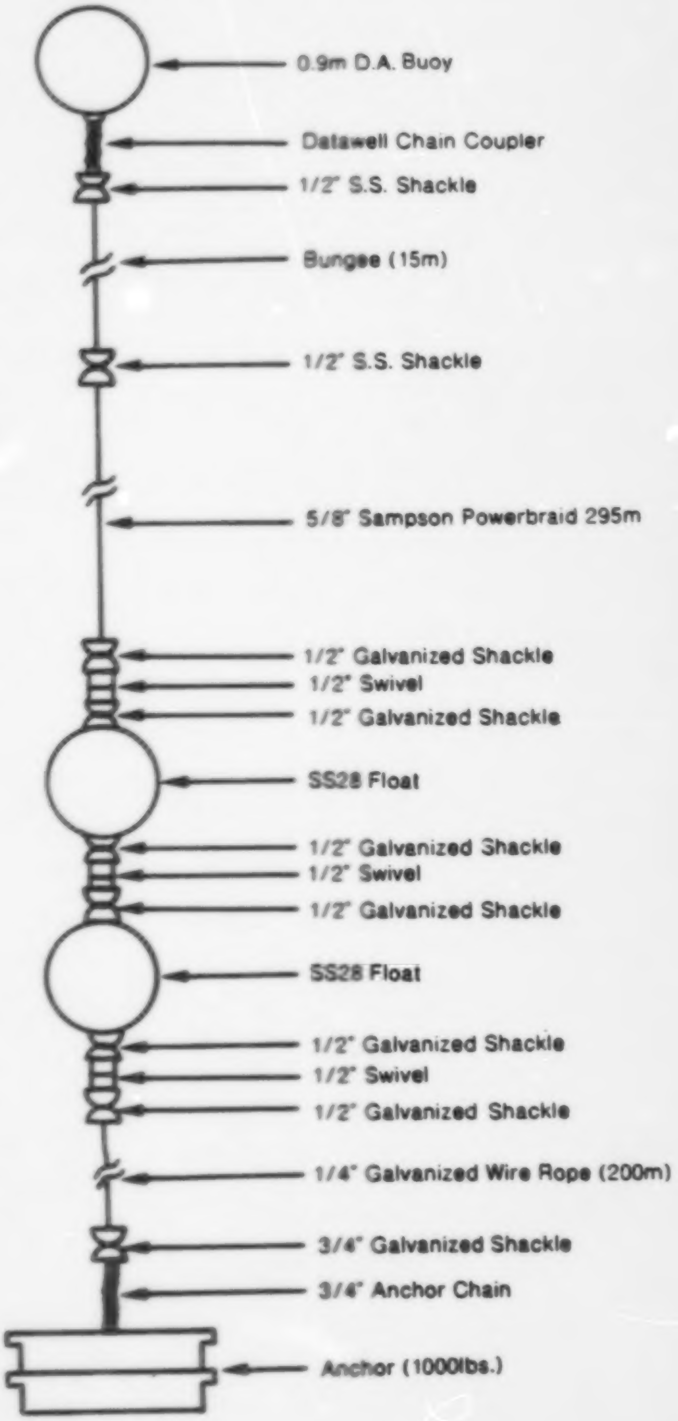
The following instrumentation and equipment will be installed on board the CCG Cutter "Hood":

1. one Internav LC-360 LORAN-C receiver and antenna;
2. one Candel Industries Limited VHF Receiver 2 Data Communications Receiver;

MOORING SCHEMATIC

NORDCO

CLIENT Transportation Development Centre / Canadian Coast Guard
LOCATION Notre Dame Bay
WATER DEPTH 365m approx.
MOORING TYPE Raised Bottom



NOTES:

1. Scope 2:1 above subsurface float
2. All powerbraid sections terminated in nylon thimbles
3. All S.S. Shackles secured by S.S Cotter Pins

3. two Compaq Portable II microcomputer systems;
4. one Datawell divar receiver and Compaq microcomputer system complete with printers;
5. a fluxgate magnetic compass unit;
6. an Omnidata Polycorder data logger unit;
7. meteorological equipment including:
    a) one R.M. Young anemometer system;
    b) two marine screens containing wet and dry bulb thermometers;
    c) sea temperature bucket with thermometer; and
    d) an aneroid barometer.
8. life raft deployment/recover equipment and repair kit;
9. 35 mm camera equipment;
10. video equipment;
11. miscellaneous hardware and supplies; and,
12. log books and stationary supplies.

As indicated above, the shipboard equipment will be installed in the first aid area on the main deck. The desk area in the survivors accommodation area will serve as an office space.

3.7 Schedule

The planned schedule as of document date is as follows:

June 01-16: Pre-trial laboratory testing of equipment and computer software.

June 19: Mobilize for three day field trial; D. Finlayson, R. Fitzgerald, J. Russell, and R. Tucker depart St. John's by vehicle for Twillingate arriving on board the CCG Cutter "Hood" in the evening.

June 20-23: Conduct initial field trials in Twillingate Harbour and vicinity.

June 24: Partial demobilization of vessel; NORDCO Limited field party returns to St. John's.

June 27-30: Equipment modifications and adjustments carried out and final preparations made.

July 04: Pack equipment aboard rental truck.

July 05: Finlayson, Fitzgerald, Russell, and Tucker depart St. John's by vehicle for Twillingate arriving in the early afternoon; party commences mobilizing the CCG Cutter "Hood".

July 06: Mobilization completed, Tucker returns to St. John's with the rental truck; wave measuring buoy deployed near the centre of the experiment area. Initial leeway experiment run made if time permits. NORDCO Limited field party of three remain on board the CCG Cutter "Hood".

July 07-18: Leeway/drift experiments continue using the four- and six-person life rafts in varying configurations. Initially, the experimental runs will be conducted in light wind conditions only. As experience is gained in managing the drifting objects, the experiment will be conducted in heavier conditions. Wave buoy recovered from mooring on July 18.

July 19: Partial demobilization of the vessel, certain gear stowed in the CCG warehouse facility in Twillingate. Field party returns to St. John's.

Jul 20- Aug 09:	Examination of the initial data set, equipment repair and modifications, and necessary software modifications carried out at NORDCO Limited.
Aug 10:	Finlayson, Fitzgerald, and Russell return to Twillingate by vehicle, arriving in the early afternoon to resume the field work, wave buoy deployed on mooring if time and weather permit.
Aug 11-23:	Leeway/drift experiments continue off Twillingate with varying life raft configurations and in varying wind and sea conditions.
Aug 24:	Wave measuring buoy recovered along with the mooring system in the morning; CCG Cutter "Hood" demobilized in Twillingate. R. Tucker arrives in rental truck to assist in the demobilization. NORDCO limited personnel return to St. John's by late evening.
Aug 25:	Truck unloaded at NORDCO Limited and returned to rental agency.

Note that the schedule is subject to change and does not include arrival and departure times for observers. It is recognized that the experiment may be interrupted at any time to respond to a SAR incident and that the ship may be required to participate in community celebration events on weekends during the summer months. As an consequence, the schedule may have to be modified and extended. The schedule will be updated and amended as necessary to keep it up to date.

3.8 Experiment Methodology

3.8.1 Data Collection

Vessel leeway is determined by vectorially subtracting the surface current from the drift object velocity. In this experiment, the velocity of the free drifting life raft will be determined from a sequence of position measurements taken at a fixed time intervals. The position of the life raft will be derived from LORAN-C time differences recorded by an on board LORAN-C receiver. The data will be stored in non-volatile RAM within the unit and, as well, telemetered to a receiver located on board the CCG Cutter "Hood". The unit will be programmed to determine and transmit its position every five (5) minutes throughout the drift period.

In a similar manner, the surface current will be derived from an array of drifting LORAN-C buoys placed in the waters surrounding the life raft. The LORAN-C buoys will be ballasted to the point were they do not experience any leeway themselves, this activity will be done during the initial trial period in June. As with the unit on board the life raft, the drifting LORAN-C buoys will transmit their positions every five minutes. The units will be synchronized so that they measure their positions at the same time; however, their transmissions will be phased to avoid garbling of the data. The velocity data from the drifting buoys will be used to estimate the surface current velocity at the raft for use in leeway determinations. Preliminary estimates will be made in the field, but the final values will be determined in the analysis phase following completion of the field work.

On board the vessel, the LORAN-C time difference data from the data communications receiver will be passed to a Compaq Portable II microcomputer which will log and process the raw data. The display will include a chart of drift object positions and the computed courses and speeds made good by the objects. To facilitate management of the LORAN-C buoys, bearing and ranges from the life raft will also be displayed on the monitor. In addition, the position of the ship will be displayed, its position being computed from the on board Internav LC-360 receiver data. Again, to aid in managing the drifting buoys, the bearing and ranges from the ship will be displayed. Certain of these data will be archived to a disk file as well.

Wind velocity will be determined using the R.M. Young anemometer systems mounted on board the ship and in the life raft. The data from these sensors, along with the vessel heading provided by the fluxgate compass unit and the platform speed computed from the positioning system will be used to compute the true wind speed and direction at the ship and at the life raft respectively. Raw data will be logged once every 15 seconds through the drift runs. On board the ship the wind data will be displayed on a Compaq microcomputer system.

The wave measuring system will compute, display, and archive the one-dimensional wave spectrum and certain primary wave parameters once very half hour. These data, along with visual estimates of sea state conditions, will be used to investigate the effect of wave induced drift of the life raft.

At least hourly, a complete environmental observation will be made. The primary parameters to be observed, in addition to wind velocity and sea state, are wet and dry bulb temperature, atmospheric pressure, and sea surface temperature. These data will enable an examination of the wind profile in the surface boundary layer to be made.

The orientation of the life raft will be monitored visually and photographically during the drift runs.

3.8.2 Wave Buoy Mooring Deployment and Recovery

Prior to conducting the drift runs, a Datawell Waverider buoy will be deployed in the centre of the experimental area. The mooring components will secured on board the vessel and the anchor mass stopped off to the outside of the ships rail. The wave buoy will be lowered over the side and allowed to drift clear. When the entire mooring has been streamed out, the anchor will be released to free-fall to the ocean floor.

In order to recover the mooring at the end of the work, the wave buoy will be recovered using the inflatable runabout and replaced with a marker buoy. The marker buoy will be hauled aboard the cutter and the mooring lifted using the ships towing winch.

3.8.3 Drift Run Scenario

Individual drift runs will be conducted in daylight conditions only and, initially, only in light or light to moderate wind conditions. Each day the CCG Cutter "Hood" will depart Twillingate at approximately 0700 local time to proceed to the upwind edge of the experiment area. In the dominant summertime wind conditions, it is anticipated that it will take slightly more than one hour to reach the start point of the experiments with the vessel steaming at 10 knots. During this period, project personnel will prepare the equipment for deployment.

At the start point the three LORAN-C buoys will be deployed directly from the CCG Cutter "Hood" and their drift monitored for a short period of time. This will serve to determine whether the surface current field is relatively uniform in the area, a condition necessary to estimate the current at the life raft. If conditions appear suitable, the instrumented life raft will be deployed within the triangular array of drift buoys. The position and environmental data collection will then begin and continue until the raft drifts through the experiment area, the current field becomes chaotic, or the approach of evening. The life raft will normally drift out ahead of the LORAN-C buoy array and it will be necessary to reposition the buoys at times. This will be done with the CCG Cutter "Hood" or, possibly at times, using the inflatable runabout. It can be anticipated that up to two drift runs will be conducted each working day.

At the end of the day, the life raft will be recovered using the deployment/recover cargo net arrangement and stowed on the afterdeck. Upon recover of the LORAN-C buoys, the cutter will return to Twillingate for the night. It is important to note that the experiment may be interrupted at any time in order to respond to a SAR mission. It is hoped that sufficient time will be available to recover the drifting objects prior to departing area; this will depend on the nature of the mission.

During the evening in port, the data will be assembled and examined. Following that, an operational plan will be prepared for the following day. As experience is gained in managing the equipment, it is expected that it will be possible to work stronger wind conditions.

REFERENCES

1. Chapline, W.E., 1960. "Estimating the Drift of Distressed Small Craft." Coast Guard Alumni Association Bulletin", U.S. Coast Guard Academy, New London, CT. Vol. 22, No. 2, March-April 1960, p. 39-42.

2. Dawe, B.R., D. Finlayson, and D. Bryant, 1988. Search and Rescue Target Detection Experiment - Canso Bank, 1987. Transportation Development Centre, Transport Canada, Montreal (in press).

3. Department of National Defence and Canadian Coast Guard, 1985. National Search and Rescue Manual. Department of National Defence and the Canadian Coast Guard, B-GA-209-001/FB-001, Ottawa.

4. Hufford, G.L., and S. Broida, 1974. "Determination of Small Craft Leeway." U.S. Coast Guard Research and Development Center Report No. 39/74, December 1974.

5. Morgan, C.W., 1978. "Seven-Man Life Raft Leeway Study." U.S. Coast Guard Oceanographic Unit Technical Report 78-1, Washington, D.C.

6. Morgan, C.W., S.E. Brown, and R.C. Murrell, 1977. "Experiments in Small Craft Leeway." U.S. Coast Guard Oceanographic Unit Technical Report 77-2, Washington, D.C.

7. Murphy, D.L., Nash L., D.F. Lundy and Omer S.R., 1982. "An Evaluation of SARP Drift Prediction Using Satellite-Tracked Drift Buoys." U.S. Coast Guard Research and Development Center, Rep. No. CG-D-05-83 Washington, D.C.

8. Nash, L., and J. Willcox, 1985. Summer 1983 Leeway Drift Experiment. U.S. Department of Transportation United States Coast Guard, Office of Research and Development Washington, Rep. No. CG-D-85.

9. Osmer, S.R., N.C. Edwards, Jr., and A.L. Breiter, 1982. "An Evaluation of Life Raft Leeway, February 1982". U.S. Coast Guard Report No. CG-D-10-82 (unpublished).

10. Pingree, F. deW., 1944. "Forethoughts on Rubber Rafts". Woods Hole Oceanographic Institution. 26 pp.

11. Scobie, R.W., and D.L. Thompson, 1979. "Life Raft Study, February 1978". U.S. Coast Guard Oceanographic Unit Technical Report 79-1, Washington, D.C.

REVISED FIELD SCHEDULE FOR THE EXPERIMENT TO DERIVE LEEWAY AND DRIFT RATES FOR COMMON SEARCH AND RESCUE OBJECTS

NOTRE DAME BAY, NEWFOUNDLAND
SUMMER 1989

Submitted to:	Transportation Development Centre and Canadian Coast Guard
Submitted by:	NORDCO Limited
Ref. No:	289-88G.002
Date:	July 19, 1989

1. INTRODUCTION

As a consequence of the late delivery of the LORAN-C buoys from the manufacturer, the schedule for the leeway experiment to be conducted in July and August 1989 has been revised. The LORAN-C drifting buoys were received at NORDCO Limited in St. John's on the afternoon of Monday, July 10, 1989. The schedule presented in the following section replaces the revised schedule dated June 11, 1989.

2. SCHEDULE

The planned schedule as of document date is as follows:

July 19:	Mobilization for initial phase of the field experiment; D. Finlayson, R. Fitzgerald, J. Russell, and R. Tucker to depart St. John's by vehicle for Twillingate arriving on board the CCG Cutter "Hood" in the afternoon or evening. NORDCO Limited field party of three remain on board the CCG Cutter "Hood".
July 20,21:	Mobilization of the CCGS SAR Cutter "Hood" at Twillingate. Conduct initial field trials in Twillingate Harbour and vicinity.
July 22:	Mobilization completed, wave measuring buoy deployed near the centre of the experiment area.
July 23-25:	Tucker returns to St. John's. Initial Leeway/drift experiments to proceed using the four- and six-person life rafts in varying configurations. Initially, the experimental runs will be conducted in light wind conditions only. As experience is gained in managing the drifting objects, the experiment will be conducted in heavier conditions.
July 26:	Wave buoy recovered from the mooring early in the day. Partial demobilization of the vessel, certain gear stowed in the CCG warehouse facility in Twillingate. Field party returns to St. John's.
July 27- Aug 15:	Examination of the initial data set, equipment modifications and repair, and necessary software modification carried out at NORDCO Limited.
Aug 16:	Finlayson, Fitzgerald, and Russell return to Twillingate by vehicle, arriving in the early afternoon to resume the field work, wave buoy to be deployed on the mooring if time and weather permit.
Aug 17-28:	Leeway/drift experiments continue off Twillingate using various life raft configurations in a range of wind and

sea conditions. Mr. Mike Kelly, CCG Ottawa, to visit the ship at some time during the period.

Aug 29: R. Tucker arrives in rental truck to assist in the demobilization. Wave measuring buoy recovered along with the mooring system in the morning. CCG Cutter "Hood" demobilized in Twillingate. NORDCO limited personnel return to St. John's by late evening.

Aug 30: Truck unloaded at NORDCO Limited and returned to rental agency.

Note that the schedule is subject to change and does not include arrival and departure times for observers. It is recognized that the experiment may be interrupted at any time to respond to SAR incidents and that the ship may be required to participate in community celebration events on certain weekends during the summer months. As an consequence, the schedule may have to be modified and extended. The schedule may also have to be extended if unforeseen events and periods of heavy weather delay the leeway experiments. The schedule will be updated and amended as necessary to keep it up to date.

3. SUPPLEMENTARY INFORMATION

3.1 CCGS Cutter "Hood"

The officers and crew aboard the CCGS Cutter "Hood" work a 28 day schedule. There will be an entire change of presonnel at noon on Wednesday, July 26, 1989. Prior to that time, Captain E. Parsons will be the Commanding Officer. Captain D. Bowes-Lyon will then be in command after the crew change.

While in Twillingate, the vessel can be reached by phoning (709)-844-2998.

3.2 Observer Visits

For individuals wishing to observe field project activities, the following accomodations are available in the Twillingate area:

Twillingate

Anchor Inn Motel (14 rooms - 8 housekeeping units overlooking the water). Phone (709) 884-2776.

Virgin Arm (1/2 hr drive from Twillingate)

High Tide Summer Cottage, phone (709) 629-3261.

Boyds Cove (1/2 hour drive from Twillingate)

Causeway Motel (10 units), phone (709) 656-3211.

Gander (1 1/2 hour drive from Twillingate)

Holiday Inn, phone (709) 256-3981

APPENDIX B

CRUISE REPORT

CRUISE REPORT

EXPERIMENT TO DERIVE LEEWAY AND DRIFT RATES FOR COMMON SEARCH AND RESCUE OBJECTS

NOTRE DAME BAY, NEWFOUNDLAND
SUMMER 1989

BY

DUNCAN FINLAYSON
REG FITZGERALD
JOHN RUSSELL
BYRON DAWE

OCTOBER, 1989

Submitted to: Transportation Development Centre
and Canadian Coast Guard

Reference No.: 289-88G.003

ACKNOWLEDGEMENTS

NORDCO Limited thanks Captain William Nash, Regional Manager Search and Rescue (SAR), Canadian Coast Guard (CCG) Newfoundland Region, for his support of the project by making available the Coast Guard Cutter (CCGC) "Hood" for the field project. The CCGC "Hood", which was recommended for use by Captain Nash early in the planning phase of the project, proved to be fully satisfactory for the required work. During the experiment period, there were two complete crew changes on the vessel. Grateful thanks is extended to the following individuals of the three crews for their full cooperation and their efforts in assisting the NORDCO Limited field party carry out the data collection:

Commanding Officer Edward Parsons
First Officer Guy Vandervaern
Chief Engineer Rod Murphy
Oiler Morgan Taylor
Seaman Edward Bridgeman
Seaman Gerard Waterman
Cook/Seaman Reg Scott

Commanding Officer Deborah Boves-Lyon
First Officers Dexter Burt and Colin Hiscock
Chief Engineer Scott Atkinson
Oiler Wayne Kilfoy
Seaman Wayne Pope
Seaman Bernard Chaffey
Cook/Seaman Herb Dimmer

Commanding Officer Gary Rendell
First Officer Guy Vandervaern
Chief Engineer Ronald Baker
Oiler Morgan Taylor
Seaman Edward Bridgeman
Seaman Cyril Best
Cook/Seaman Reg Scott

Thanks are also extended to Mr. Mike Kelly, Superintendent SAR Research & Development, CCG Ottawa for guidance in selecting SAR drift objects and configurations. NORDCO Limited thanks Dr. R. Quincy Robe, United States Coast Guard (USCG) Research and Development (R&D) Center, Groton, Connecticut for the loan of two anemometer/fluxgate compass systems and for the advice that he provided. Further, thanks are extended to Dr. Arthur Allen, also of the USCG R&D Center, for the advice and suggestions freely given during his visit on board the CCGC "Hood" during the experiment.

TABLE OF CONTENTS

1. INTRODUCTION 1

2. EXPERIMENT OVERVIEW 2
    2.1 Experiment Objectives 2
    2.2 Experiment Location 2
    2.3 Experiment Time Frame 4
    2.4 Relevant Characteristics of the CCGC "Hood" 4
    2.5 Participants 5
    2.6 Instrumentation and Equipment 5
    2.6.1 Moored Instrumentation 5
    2.6.2 Free Drifting Instrumentation and Equipment 5
    2.6.3 Shipboard Instrumentation and Equipment 6
    2.7 Experiment and Methodology 6
    2.7.1 Data Collection 6
    2.7.2 Drift Run Scenario 8
    2.8 Drift Run Summary 9
    2.9 Problems Encountered 9
    2.9.1 Sea Rover 3 Drifting Buoys 9
    2.9.2 Other Problems 12

3. CHRONOLOGY OF EVENTS 13

REFERENCES 25

List of Figures

Figure 1 Experiment Location
Figure 2 Wave Buoy Mooring Arrangement

List of Tables

Table 1 Summary of Drift Runs

1. INTRODUCTION

In December 1988, NORDCO Limited was awarded a contract by Supply and Services Canada (T8200-8-8527/01-SD) on behalf of the Transportation Development Centre (TDC), Transport Canada, to conduct a search and rescue (SAR) object leeway and drift experiment. Preparations for the experiment began in January and ended in mid-July 1989. The field work was carried out in Notre Dame Bay, Newfoundland during the summer of 1989. As the work of the current contract is to be the first of a series of leeway and drift experiments to be conducted over a multi-year period, the field experiment served to develop and establish a methodology to determine the leeway of drifting objects and to collect life raft drift data and concurrent environmental data. This report contains a detailed summary of the field activites that were undertaken to fulfil contract obligations.

Analysis of the data will be carried out during the autumn of 1989; the final report on the project will be prepared during the winter of 1989/90 for delivery to TDC on or before March 15, 1990. The results of the project are ultimately expected to be used to update SAR planning guidance material provided in the National Search and Rescue Manual (Department of National Defence and Canadian Coast Guard, 1985). The expected benefit of the work is an improvement of the overall effectiveness of marine SAR operations.

The Newfoundland Region of the Canadian Coast Guard (CCG) supported the project by providing a ship from which the field work was conducted. The CCGC "Hood", the SAR vessel normally based in Twillingate, Newfoundland during the summer months, was made available as the research platform for the experiment whenever it was not required for SAR operations.

2. EXPERIMENT OVERVIEW

2.1 Experiment Objectives

The primary objective of the field work was to obtain quantitative leeway and drift information for common SAR objects under a range of environmental conditions. For this initial field experiment, the SAR object was limited to a four-person inflatable canopied life raft in various configurations. A small inflatable life raft was selected since these life rafts are commonly carried on board small fishing, commercial, and pleasure craft and because they are known to experience relatively high leeway speeds. In addition to an investigation of the drift and leeway, the approach and methodology was to be evaluated in order to benefit future experiments of this nature.

2.2 Experiment Location

The experiment was conducted in the waters of Notre Dame Bay, Newfoundland just to the north of Twillingate Island (see Figure 1).

The Notre Dame Bay area was selected for the following reasons:

1. The LORAN-C coverage using time differences from the Canadian East Coast chain (GRI 5930) was believed to be adequate for drift object position determinations.
2. In addition to being the base of operations for the CCGC "Hood" during the summer months, the CCG maintains a small operations base adjacent to the government wharf in Twillingate which has both office and warehouse space.
3. The current was expected to be fairly uniform in the horizontal plane, simplifying the task of determining an interpolated surface current at the postion of the drift object.
4. Fishing activity in the area was expected to be relativly light.
5. Other vessel traffic was expected to be light, minimizing interference to the experiment.
6. Wind and sea conditions in Notre Dame Bay during the summer months were expected to be conducive for experiment activities.

In general, all the expectations were realized.

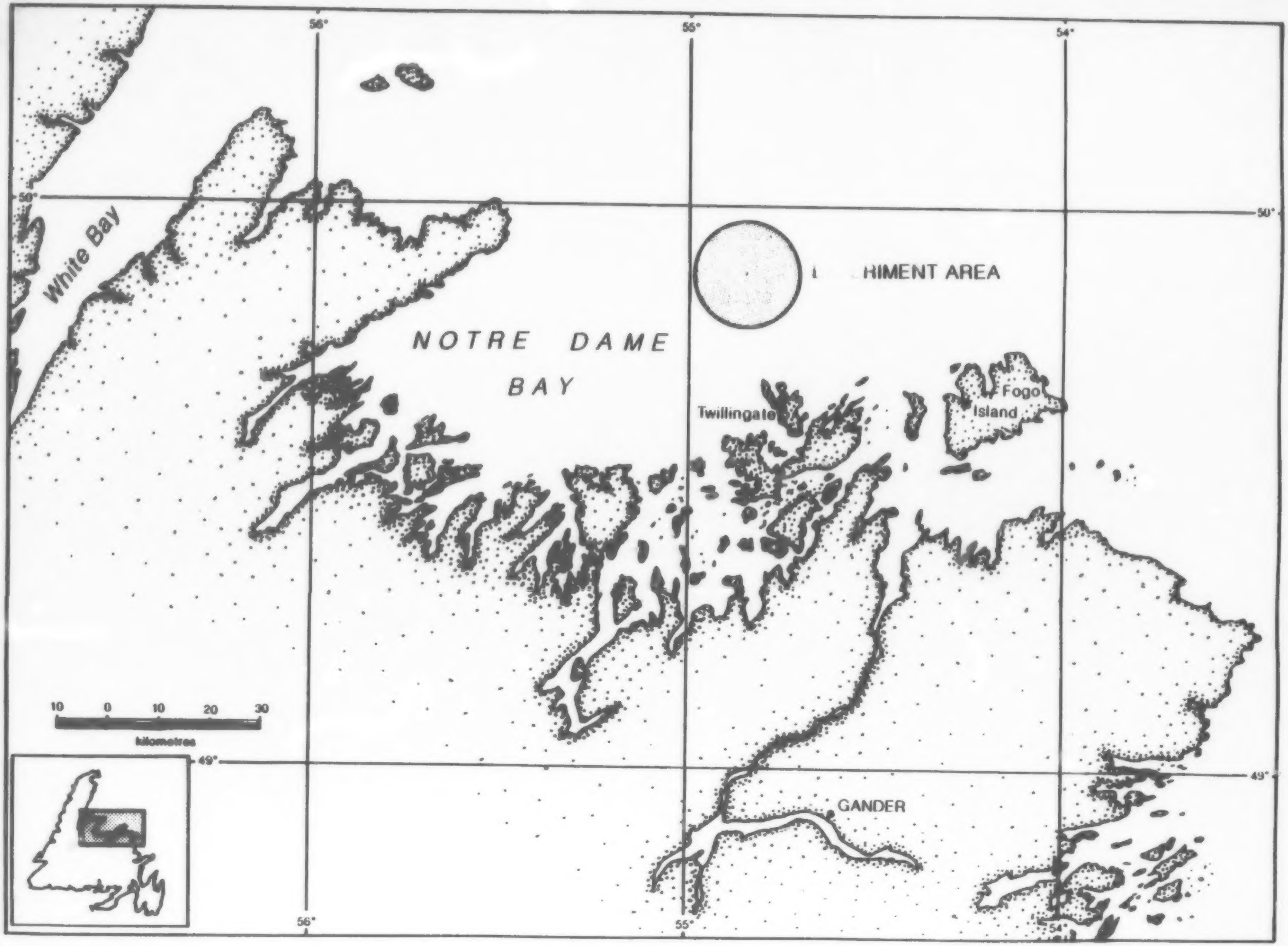


FIGURE 1 Experiment Location

2.3 Experiment Time Frame

The field work was carried out in three distinct phases beginning on July 19, 1989 and ending on Sepember 18, 1989. Mobilization of the vessel at Twillingate, Newfoundland, and initial field trials on Notre Dame Bay were conducted from July 19 to July 28, 1989. Modifications, testing, and repair of certain equipment, and some modifications to software were done in St. John's in the period July 31 to August 16, 1989. From August 17 until August 31, 1989, a series of 8 drift runs were made off Twillingate. Following a break of one week when additional software modifications were made, the field work was resumed. Between September 08 and September 17, 1989, a further 6 drift runs were conducted. Instrumentation and equipment was then removed from the vessel. The field party returned to St. John's on September 18, 1989. A detailed chronology of events is provided in Section 3 of this cruise report.

2.4 Relevant Characteristics of the CCGC "Hood"

The vessel has an overall length of 24 metres (m) and a beam of 7.6 m. Deck space is minimal but was adequate for the management and stowage of project equipment. The after deck is equipped with a PM Autogru crane and an inflatable runabout. The crane, with a safe working load of 1400 kilograms (kg) at 7.5 m reach, was adequate to handle the ballasted life rafts and wave buoy mooring equipment. The low freeboard facilited the handling of equipment over the side.

Immediately forward of the afterdeck is the survivor receiving area and first aid station. This area is equipped with a berth and several lockers above the berth. This space was sufficient to support project requirements for navigation equipment, wave monitoring equipment, computer systems, and ancillary gear. Antenna leads and the anemometer signal cable were led along an adjacent stairway to the bridge deck then, from there, to the monkey island and the mast. There was no requirement for equipment space in the wheelhouse.

The normal ships complement is 7 persons. In addition to crew accommodation, the vessel has a "survivors" cabin which has 8 berths, a head, and a desk. The survivors cabin was made available for project personnel. The galley/mess facilities were found to be adequate to handle project personnel in addition the the normal complement.

2.5 Participants

The leeway/drift field experiment was conducted by the following NORDCO Limited personnel:

Duncan Finlayson, Project Manager
Reg Fitzgerald
John Russell

A NORDCO Limited electronics technician, Mr. Ross Tucker, assisted with the installation and testing of the instrumentation and equipment during the vessel mobilization in mid-July. A computer programmer from NORDCO Limited, Mr. Mario Godinez, joined the ship from late on August 21 until the early evening of August 24, 1989. At the same time, Dr Arthur Allen of the USCG R&D Center, was visiting the CCGC "Hood" as an observer.

As was anticipated, in addition to the NORDCO Limited field party, two crew members were required to help with the deployment and recovery of the life raft and the drifting buoys.

2.6 Instrumentation and Equipment

2.6.1 Moored Instrumentation

A Datawell Waverider buoy was deployed on a single point mooring system in position 49°50.6′N latitude, 54°50.0′W longitude in the experiment area. The water depth at the mooring location was 360 m. A raised bottom mooring with a 2:1 scope above the sub-surface floats was employed. Figure 2 illustrates the mooring arrangement. The mooring was successfully deployed on July 23, 1989 and fully recovered on September 15, 1989. The vessel's crane was used to assist in the deployment of the mooring while both the crane and towing winch were used during the recovery operation. The wave measuring buoy functioned properly throughout the full period of deployment.

2.6.2 Free Drifting Instrumentation and Equipment

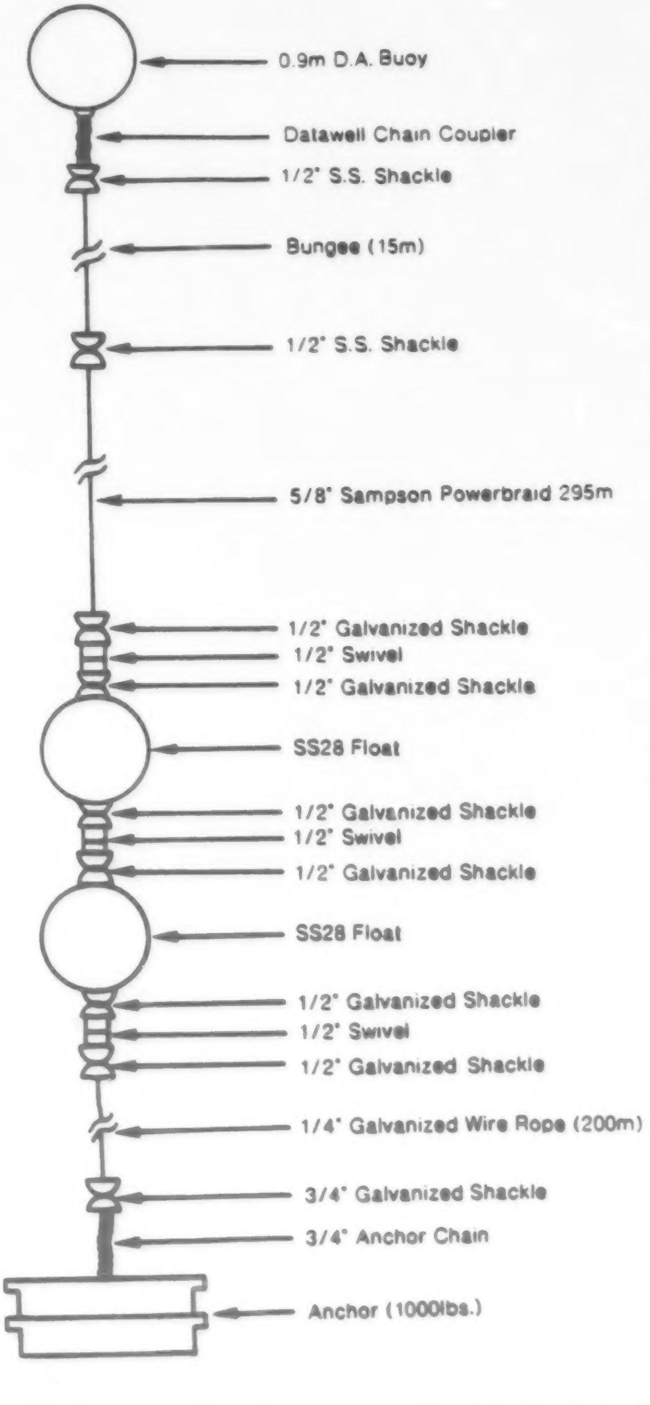
A four-person and a six-person life raft were fitted out with plywood floors prior to going into the field. Instrumentation was secured to the floor boards of the four-person life raft during the mobilization period. The life raft instrumentation included:

1. one Candel Industries Limited Sea Rover 3 LORAN-C buoy with integral VHF transmitter,
2. one R.M. Young anemometer system,
3. one fluxgate magnetic compass unit, and,
4. one Omnidata Polycorder data logger.

Ballast material, composed of gravel filled automotive tire inner tube segments, was placed on the floor around the instrumentation.

Tests were conducted on drifting life rafts with and without drogues and with varying amounts of ballast. A weight of approximately 79.5 kg was used to simulate the weight of one person. Drift runs were made using half and full life raft loading (2 and 4 persons).

The surface current field was measured by tracking an array of Sea Rover 3 drifting buoys deployed in the waters surrounding the free drifting life raft. Three buoys were normally deployed along with the life raft. The Sea Rover 3 buoys contain a LORAN-C receiver and a VHF transmitter. These drifting buoys were identical to the unit secured inside the life raft.



NOTES : 1. - S.S. Stainless Steel
2. Scope 2 : 1 above subsurface float
3. All powerbraid sections terminated in nylon thimbles
4. All S.S. Shackles secured
5. m - metres

FIGURE 2 Waverider Bouy Mooring Arrangement

2.6.3 Shipboard Instrumentation and Equipment

The following instrumentation and equipment was installed on board the CCGC "Hood":

1. one Internav LC-360 LORAN-C receiver and antenna,
2. one Candel Industries Limited VHF Receiver 2 Data Communications Receiver,
3. two Compaq Portable II microcomputer systems and OKIDATA Printer,
4. one Datawell Divar receiver and Compaq microcomputer system complete with printer,
5. one fluxgate magnetic compass unit,
6. one Omnidata Polycorder data logger unit,
7. meteorological equipment including:
    - a) one R.M. Young anemometer system,
    - b) two marine screens containing wet and dry bulb thermometers,
    - c) sea temperature bucket with thermometer, and,
    - d) one aneroid barometer.
8. life raft deployment/recover equipment and repair kit,
9. one 35 mm camera equipment,
10. video equipment.

As indicated above, the shipboard equipment was installed in the first aid area on the main deck.

2.7 Experiment Methodology

2.7.1 Data Collection

In the analysis phase, the SAR drift object leeway will be computed by vectorially subtracting the surface current from the object drift velocity. In this experiment, the velocity of the free drifting life raft is to be determined from the sequence of LORAN-C position determinations taken at fixed time intervals throughout the individual drift runs. The data was stored in non-volatile Random Access Memory (RAM) within the LORAN-C unit and, as well, was transmitted to a receiver located on board the CCGC "Hood". The record and transmit interval was set to 5 minute (min) for all drift runs.

In a similar manner, the surface current at the life raft is to be estimated from an analysis of drift velocity of the LORAN-C drifting buoys that were deployed in the waters surrounding the life raft. The LORAN-C buoys were modified with fins to increase the frontal area to the surface current and were ballasted to reduce their freeboard to approximately 7.5 centimeters (cm). In a drift test against a plywood drogue having zero freeboard and extending to the same draft as the LORAN-C drifting buoys, the contribution of the drift attributed to leeway was deemed to be negligible. This will be discussed in detail in the project final report. The Sea Rover 3 buoy clocks were synchronized in order to obtain position data at the same time; however, their transmissions were phased to avoid garbling of the data.

On board the vessel, the LORAN-C time difference data from the data communications receiver were passed to a Compaq Portable II microcomputer which logged and processed the raw data. The software graphics included a display of the drift object positions and the computed courses and speeds made good by the various objects. To facilitate management of the LORAN-C buoys, bearing and ranges from the life rafts were displayed on the monitor. In addition, the position of the ship was computed from the Internav LC-360 receiver LORAN-C time difference data. Again, as an aid in managing the drifting buoys, the bearing and ranges from the ship were displayed. Throughout the data collection period, spurious signals output from the VHF receiver caused the program to lock up at times. The source of the signals was not determined. The problem was intermittent; on some days no problems were experienced, while on other days the problem would persist for several hours at a time. Since the position data was logged on board the buoys as well as on the vessel, the problem was of little overall significance; however, it made the job of monitoring and managing the free drifting buoys more difficult. The communications handling routines were modified a number of times during the field experiment. Limitations of the programming language precluded the successful elimination of the problem. Recommendations of further software modifications will be presented in the project final report.

Wind velocity was determined using R.M. Young anemometer systems mounted on board the ship and in the life raft. The data from these sensors, along with the vessel heading, provided by a fluxgate compass unit, and the platform speed and course made good, computed from the position data, will be used to compute the true wind speed and direction. Initially, the raw data was logged once every 15 seconds (s) throughout the drift runs. Later in the program, the logging program for the life raft wind data was changed to sample once a second for 10 s on a 2 min cycle throughout the runs. On board the ship, the wind data were displayed on a Compaq microcomputer system. These data were used to compute a true wind velocity at the ship.

A standard wave processing procedure was used to obtain measured wave data. In a 30 min period, eight 200 s data samples were automatically received from the wave buoy. A one-dimensional wave spectrum and certain wave parameters were computed from these data. The primary parameters of concern were significant wave height and average wave period. These measured data, along with visual estimates of sea state conditions, were recorded on environmental data log sheets every half hour thoughout a drift run.

A comprehensive environmental observation was made every 30 minutes while the life raft was drifting free. The primary parameters that were observed, in addition to wind velocity and sea state, included wet and dry bulb temperature, atmospheric pressure, and sea surface temperature. These data when entered into a surface boundary layer model will enable a specification of the near-surface wind profile to be made. Other parameters that were logged included sky conditions, visibility, and degree of white capping.

The orientation of the life raft was recorded using the on board fluxgate compass system. The data logging interval was the same as for the wind speed and direction data.

2.7.2 Drift Run Scenario

Individual drift runs were conducted in daylight conditions only and, for the most part, in light to moderate wind conditions (wind speed less than 20 knots (kt)). Portions of some runs, however, were made in winds of 20 to 25 kt. Whenever possible the CCGC "Hood" would depart Twillingate around 0800 local time to proceed offshore beyond the 100 m isobath to a starting point from which the expected drift track would be unlikely to pass over shoals or to approach the coast. In general, it took approximately one hour to reach the chosen start point, with the vessel steaming at 10 kt. During this period, project personnel prepared the equipment for deployment. At times, deck work could not be done while the ship was steaming because of water washing across the deck.

For logistical convenience, the instrumented life raft was deployed first. A LORAN-C buoy was then lowered into the water. The life raft and buoy were usually set adrift at the same time. After monitoring the drift for approximately 5 to 15 min, a second LORAN-C buoy was deployed at a distance of approximately 500 to 1000 m from the life raft at an angle of about 10 to 25 degrees off the downwind direction. Normally the third buoy was launched shortly afterward at roughly the same distance from the life raft across the wind from the second buoy. The environmental observation program began with the deployment of the life raft and continued until the end of the drift run.

The buoy positions relative to the life raft were monitored continuously throughout the run. To be able to develop an accurate estimate of the surface current at the life raft, general guidelines regarding the buoy positions relative to the life raft were established at the beginning of the field program. An attempt was made to keep the life raft contained within the triangle defined by the drifting LORAN-C buoys and to keep the individual life raft to buoy distances less than about 1500 m. Whenever it was necessary, one of the drifting buoys was recovered and then redeployed in an appropriate position in an effort to satisfy these criteria. The deployment and recovery of life raft and the buoys were carried out using the ship's crane. Normally 2 individuals and the crane operator were necessary handle the buoys. 4 persons, in addition to the crane operator, were required to manage the life raft. A custom-built cargo net arrangement was used to deploy and recover the life raft.

Drift runs were normally ended about 1800 local time. Following recovery of the drifting equipment, the cutter returned to Twillingate for the night. In the evening, the LORAN-C time difference data were downloaded from the buoys to a disk file on a microcomputer, then subsequently archived on floppy diskettes. Similarily, the wind data recorded on the ship and on board the life raft were downloaded and archived. After confirming the integrity of the data files and completing drift run documentation, certain preparations were made for the following day.

2.8 Drift Run Summary

A total of 16 drift runs of varying duration were conducted during the field program. Table 1 contains a brief summary of each of the drift runs including SAR drift object characteristics, range of primary environmental conditions, duration of the drift run, and so forth.

2.9 Problems Encountered

2.9.1 Sea Rover 3 Drifting Buoys

Significant problems were encountered early in the field project which were related to the performance of the Sea Rover 3 LORAN-C drifting buoys. Originally scheduled for delivery from the manufacturer at the middle of May 1989, the buoys were finally received in St. John's on July 10, 1989. As a consequence, it was necessary to make several adjustments to the planned field schedule. An initial three-day field trial was postponed until early July, then later cancelled. The start date for the first portion of the field work was changed from July 04 to July 14 and finally to July 19, 1989. These changes were made in accordance with a series of delays in the delivery of the LORAN-C buoys from the manufacturer. On July 18, 1989, only 8 days after receiving the buoys and the day before leaving for the field, one of the units failed. After phone discussions with the manufacturer, it was decided to return the unit by air express for repair; however, it was decided to proceed into the field with the 3 remaining buoys. At a later date, the manufacturer stated that a number of chips on the controller board had suffered failure; apparently, no reason for the failure could be determined.

Once in the field further difficulties arose. A buoyancy check showed that the buoys floated at an angle when equipped with a floatation collar or in a horizontal attitude without the collar. The addition of 12.5 kg of lead ballast secured at the bottom of the unit corrected the problem and, advantageously, decreased the freeboard by approximately 2.5 cm.

RUN No.	DATE 1989	START TIME (GMT)	END TIME (GMT)	DURATION (Hour : Minute)	LIFE RAFT CONFIGURATION	NUMBER OF PERSONS IN LIFE RAFT	WIND DIRRECTION (TRUE) WIND SPEED (KNOTS)	AVERAGE SIGNIFICANT WAVE HEIGHT (m)	REMARKS
1	JUL 24	2050	2305	2:15	D	2	SE-5	1.2	Initial run
2	JUL 27	1114	2027	9:13	D	2	SW/E-8	0.4	One buoy only
3	AUG 20	1253	2028	7:35	D	2	SW-16	0.7	
4	AUG 21	1738	2255	5:17	D	2	S-10	0.7	
5	AUG 22	1247	2123	8:36	D	2	NNE-11	1.0	
6	AUG 24	1157	2050	8:53	D	2	NE-8	1.5	
7	AUG 25	1142	2045	9:03	D	2	SW/W-15	1.3	
8	AUG 26	1636	2110	4:34	D	2	VRBL-6	1.8	
9	AUG 28	1109	2020	9:11	D/U	2	NW-20 to lgt	1.9	
10	AUG 29	1703	2055	3:52	U	2	S-10	1.2	
11	SEP 09	1733	2052	3:19	U	2	SW-10	0.4	Wind speed suspect
12	SEP 10	1158	2055	8:57	U	2	SSW-7,ENE-15	0.9	
13	SEP 11	1157	2003	8:06	U	4	SW-7,NE-15	1.3	
14	SEP 14	1359	1812	4:13	D	4	WNW-20	1.1	
15	SEP 16	1206	2044	8:38	D	4	NW-25,E-10	1.4	Two buoys
16	SEP 17	1142	1817	6:35	D	4	SW-14	1.0	Two buoys

TABLE KEY : D = DROGUE STREAMED
U = DROGUE NOT STREAMED

TABLE 1 SUMMARY OF DRIFT RUNS

In the morning following drift run R01, the data files from the buoys were downloaded to the microcomputer. The data from one unit (B26) was downloaded successfully and appeared to be of good quality. The data file from buoy B28 was found to contain a significant number of errors in the records, although no reason for the errors was apparent. When an attempt was made to download the position data from the buoy in the life raft (B22), the unit failed to respond in the normal manner. Further attempts were made following a number of telephone calls to the manufacturer in British Columbia. By the end of the day, it was decided to send the electronics package back to the manufacturer. The buoy electronics package was dispatched by air express the following day; just 16 days after it was originally received. The problem was determined to be a corrupted Erasable Programmable Read Only Memory (EPROM).

With only 2 operational buoys, a second drift run (R02) was made prior to returning to St. John's. The format and position data of the downloaded data appeared to be correct although time discrepancies were noted. Following run R02 it was decided that the addition of fins to the body of the buoys would be advantageous; it was believed that the modification would improve their motion characteristics in the water, reduce the freeboard further, and faciliate handling and securing the buoys on board the ship. The USCG had, it is noted, previously made similar modifications to an early model of the Candel Industries LORAN-C buoys.

Upon return to St. John's, a fin design was drawn up and the fins fabricated in the NORDCO Limited machine shop. The software to process the position data onboard the ship was modified in a attempt to handle the numerous errors in the data records that had been received from the buoys, and further testing of the buoys was carried out. These tests were conducted on all of the buoys, the malfunctioning buoys having been received back from the manufacturer. The tests showed that the clocks in all four buoys were not functioning correctly. Consequently the following day, August 10, 1989, all four of the buoy electronics assemblies were returned to the manufacturer in British Columbia.

The problem common to all units was the low voltage of the battery that supplied power to the RAM, Read Only Memory (ROM), and real time clock. The solution was to replace the battery and to increase the voltage output supplied by the internal power supply circuitry. The buoys arrived back at NORDCO Limited in St. John's on August 15, 1989 in proper working order. The real time clocks functioned correctly and the data stored in memory was logged without errors. Only one small problem was evident: buoy B24 failed to output the voltage of its primary battery pack when an inquiry was made, but this did not impact on its operation.

The LORAN-C buoys functioned properly until a few days before the end of the field work. On September 15, 1989, the buoy mounted in the life raft (B22) failed to respond in the normal manner during the predeployment check-out, and could not be used further. The unit was replaced with one of the other buoys, leaving only two free drifting buoys available for the runs that were conducted during the final two days of the field work. Upon completion of the field project, it was found necessary to return 3 of the 4 Sea Rover 3 drifting buoys to the manufacturer for diagonistic testing and subsequent repair.

2.9.2 Other Problems

With regard to other instrumentation and equipment, the only other problems that were experienced involved the data logger that was mounted in the life raft to log wind velocity and heading data. The data file for the first run was found to be corrupted; while the cause of the problem was unknown, the problem proved to be of little concern since the life raft position data for the run was also not available; the recorder then functioned normally until drift run R09. On that occasion, it was not possible to download the data file from the logging unit to a microcomputer following the run. However, the entire memory of the unit was saved to a disk file on the microcomputer and, with additional documentation provided by the data logger manufacturer, the data were fully recovered at a later date. The problem was inexplicably caused by a corrupted format file name.

3. CHRONOLOGY OF EVENTS

This section contains a daily summary of events for each of the three periods in which field work was conducted, as well as a brief description of project activities in the intervening time.

Wednesday, July 19, 1989

The truck was picked up from the rental agency. The field equipment manifest was checked as the gear was packed aboard the truck. John Russell, Ross Tucker, Reg Fitzgerald, and Duncan Finlayson departed NORDCO Limited by rental truck and private vehicle in the mid-afternoon and arrived in Twillingate late in the evening. The NORDCO Limited group met briefly with some of the officers and crew of the CCGC "Hood" and stayed on board the ship overnight. Accommodation was provided in the "survivors" cabin.

Thursday, July 20, 1989

After providing the captain and first officer with an overview of the planned work, mobilization of the ship began. The full cooperation of the crew was offered by the captain. A LORAN-C and two VHF antennas were required to be mounted on the monkey island rail, and antenna leads and data communications cables run from the monkey island to the main deck. An anemometer and fluxgate compass unit had to be installed on the ship's mast; as well, a barometer and marine screens to contain wet and dry bulb thermometers needed to be mounted. A plywood equipment support shelf unit had to be constructed to fit the berth in the vessel's first aid area. Chocks were fitted to the unit in order to adequately secure the receivers, microcomputers, printers, and so forth. A life raft required fitting out with the prefabricated plywood floors, anemometer/fluxgate compass system, and Sea Rover 3 LORAN-C buoy. The life raft deployment/recovery net arrangement had to be assembled. Finally, all instrumentation and equipment needed to be checked out.

Friday, July 21, 1989

Mobilization continued throughout the day. A floatation check of the LORAN-C buoys was carried out. It was found necessary to add ballast to the bottom of the case in order for the buoy to float in the correct attitude. The remaining meteorological equipment was installed. The equipment shelving assembly was completed and some checks of the various systems made. Some difficulty was found in acquiring LORAN-C time differences on LORAN-C either of the two LORAN-C chains available in the area. The problem was later traced to a problem with the antenna mounting coupler.

Saturday, July 22, 1989

Mobilization continued with the installation of the wave measuring computer system and ancillary gear, the mounting of the fluxgate compass unit, and the outfitting of a canopied four-person life raft.

Sunday, July 23, 1989

The morning was spent rigging the wave buoy mooring system components and all equipment and instrumentation was checked out. The life raft deployment/recovery net arrangement was assembled. The CCGC "Hood" departed Twillingate at 1450 NDT to deploy the wave buoy mooring system and to conduct some initial tests. The mooring was deployed at 1640 NDT without incident in position 49°50.6'N latitude, 54°50.0'W longitude in a water depth of 360 m. A dummy buoy was deployed with the mooring. A NOTSHIP was sent out which provided details of the deployment. The compass system was calibrated against the ship's gyrocompass and a deviation chart prepared. Two life raft deployment/recovery tests were made and a LORAN-C buoy was set adrift along with plywood drift cards in order to assess the leeway of the buoys.

The ship departed the experiment area at 1920 NDT, arriving at Twillingate at 2030 NDT. Some changes were necessary to a data file that was required for the proper operation of the positioning system computer program. This work was done in the evening and the program allowed to run overnight in order to examine the scatter of the LORAN-C time difference data on LORAN-C chain 5930.

Monday, July 24, 1989

Ross Tucker departed for St. John's at 0800 NDT in the rental truck. Based on the previous days tests, the lifting net assembly was modified. Among other minor equipment replacements and adjustments, it was found necessary to repair the antenna lead for the life raft mounted LORAN-C buoy. Prior to leaving port, the computers, LORAN-C buoys, and data loggers were synchronized and otherwise initialized in order to conduct the initial drift run. The CCGC "Hood' departed Twillingate in the afternoon. Upon arrival at the location of the wave buoy mooring, the dummy buoy was replaced with a Datawell Waverider buoy. The entire system was found to function normally.

The initial drift test, identified as run R01, was conducted using only one LORAN-C buoy along with a drogued four-person life raft. The objects were set adrift at 1820 NDT; the run was terminated at 2030 NDT. Upon recovery the anemometer became snagged in the spreader assembly but no damage occurred. The ship returned to Twillingate for the night at mid-evening.

Tuesday, July 25, 1989

It had been planned to proceed to the experiment area following the downloading and archiving of the position and the wind data from run R01.

Unfortunately, a number of problems occurred: the life raft wind velocity and heading data file was corrupted, a number of errors were noted in the records downloaded from one buoy, and no response was obtained from the buoy that was mounted in the life raft. The unit had become totally unservicable. These equipment problems are discussed in detail in Section 2.9. The remainder of the day was spent determining and correcting the difficulties to the degree that was possible in the field.

Wednesday, July 26, 1989

A planned change of the entire crew at mid-day precluded heading out to conduct an experiment run in the morning. CCG electronics technicians also arrived in the morning to carry out modifications to the internal communications equipment on the CCGC "Hood". The ship remained at Twillingate during the afternoon in order that the work could be done. Two of the NORDCO limited field party members took the opportunity to travel to Gander, Newfoundland in order to air express the faulty LORAN-C buoy back to the manufacturer in British Columbia.

A SAR call was received at about 1630 NDT. After lifting the remaining LORAN-C buoys and the instrumented life raft onto the wharf, the CCGC "Hood" departed Twillingate. While returning to Twillingate late in the evening, the CCGC "Hood" was required to respond to a second SAR call.

Thursday, July 27, 1989

The CCGC "Hood" arrived Twillingate at 0540 NDT with a longliner in tow. The NORDCO Limited equipment was then loaded on board. Upon the arrival of the CCG technicians at 0625 NDT, the CCG "Hood" departed Twillingate to conduct drift run R02. The four-person drogued life raft, the LORAN-C buoys, and four plywood drift cards were set adrift at 0844 NDT, beginning run R02. It appeared that there was a significant difference in the response of the surface keyed drift cards and the deeper draft LORAN-C buoy. The cards were recovered at 1135 NDT and replaced with a drift card having a keel depth of 0.5 m. The purpose of the test was to compare the leeway response of a LORAN-C buoy, which had a freeboard of 12.5 cm with a drift object having an effective freeboard of zero height, that is having no leeway. The position monitoring program locked up a number of times during the afternoon. The problem was judged to be due to the receipt of noisy data by the VHF receiver. The buoy was recovered at 1737 NDT; the run was terminated with the recovery of the life raft at 1807 NDT. Since this completed the first phase of the field work, the wave measuring buoy was recovered at 1900 NDT; it was replaced with a dummy buoy as a safety measure. The CCGC "Hood" then returned to Twillingate.

Run R02 data was then downloaded and archived and the ship partially demobilized. The work was completed at 0100 NDT the following morning.

Friday, July 28, 1989

After packing certain equipment that was required to be modified or repaired; R. Fitzgerald, J. Russell, and D. Finlayson departed Twillingate at 0810 NDT by private vehicle. The party arrived at NORDCO Limited in St. John's at 1540 NDT.

Monday, July 31, to Wednesday, August 16, 1989

The following project related work was conducted during this period of time. The front end of the position monitoring program was modified in an effort to improve its ability to handle and process particularily noisy position data records. The buoys were worked with extensively in the software trials. A suspected problem with the clocks in the LORAN-C buoy was rigorously tested. On August 10, all four LORAN-C buoys were returned to the manufacturer. The buoys were recieved back at NORDCO Limited in operational order on August 15, 1989 (see Section 2.9 for further details). In addition to the properly functioning clocks, the data stored in RAM was found to contain virtually no errors and less noisy data was received by the VHF receiver. The entire gamut of problems that had been experienced was due, it seems, to an internal power supply problem common to all of the LORAN-C buoys. Finally, 3 sets of aluminum fins were designed and fabricated to improve the efficiency of the drifting buoys.

Thursday, August 17, 1989

Upon completion of final preparations, the NORDCO Limited field party consisting of R. Fitzgerald, J. Russell, and D. Finlayson departed St. John's by private vehicles at 1600 NDT. The group arrived in Twillingate at 0030 NDT the following morning.

Friday, August 18, 1989

The computers and receivers were set-up during the morning and tested in the afternoon. Some changes were required to make the positioning system software operational following the laboratory testing in St. John's. The new fin assemblies were fitted to the bodies of the LORAN-C buoys. An uninterruptable power supply for the experiment electronic equipment was secured in the first aid station area of the vessel and the fluxgate compass unit was repositioned aloft just forward of the ship's mast.

Saturday, August 19, 1989

The LORAN-C buoys, life raft, and wave measuring buoy were lifted aboard the ship in the morning and the life raft was fitted out with a LORAN-C buoy and a Polycorder data logger. All preparations were completed by mid-day. The CCGC "Hood" departed Twillingate at 1300 NDT bound for the wave buoy mooring position. The dummy buoy was replaced with the waverider buoy at 1445 NDT; the wave measuring system was found to be fully operational. A drift test was then carried out. The three LORAN-C buoys, in addition to being equipped with fins, were provided with varying amounts of ballast: no additional ballast, 8.6 kg of lead, and 16.3 kg of lead. The freeboard of the buoys ranged from 12.7 cm to 9.0 cm. A plywood drift "card", equipped with a bi-axis keel with a draft very near to that of the LORAN-C buoys (near 1.15 m) and ballasted for zero freeboard, was deployed with the LORAN-C buoys at 1503 NDT and then recovered between 1808 NDT and 1829 NDT. The difference in drift that was attributable to leeway was only a small precentage of the total drift. Having re-mounted the fluxgate compass, it was necessary to determine its deviation by calibrating the compass output against the ship's gyrocompass. This was done during the LORAN-C buoy drift test.

After returning to Twillingate at 1940 NDT, the position data collected during the test run were downloaded successfully from all buoys and archived under the name Test T03.

Sunday, August 20, 1989

The CCGC "Hood" departed Twillingate at 0810 NDT. After initializing all equipment and synchronizing the clocks, the life raft was deployed. During deployment the anemometer sensor unit had been pulled off the mount by one of the lifting straps. The unit was recovered and reassemblied. Both direction and speed calibration checks proved that the unit was functioning correctly. The life raft was re-deployed and then set free with a LORAN-C buoy at 1020 NDT, beginning run R03. The other LORAN-C buoys were then deployed. Whenever necessary the free drifting buoys were recovered and then re-deployed nearer the life raft. The run continued until 1750 NDT, at which time the ship was brought alongside the life raft for recovery. The vessel was enroute for Twillingate at 1800 NDT, arriving at 1840 NDT. The data were downloaded from the buoys and the life raft data logger in the evening. All the data appeared to be in excellent condition.

Once again, the position monitoring program began to cause problems during the afternoon. No apparent reason for the computer lock up was evident.

Monday, August 21, 1989

The morning was spent attempting to understand why the position monitoring program was hanging up. Late in the morning, B. Dave of NORDCO Limited was called and asked to send a programmer to Twillingate to solve the problem.

The vessel departed Twillingate at 1400 NDT in order to conduct run R04. The drogued life raft was set free to begin the run at 1511 NDT. The LORAN-C buoys were deployed in the vicinity of the life raft and then recovered and re-deployed in the usual manner to keep them in the vicinity of the life raft throughout the drift period. Run R04 ended with the recovery of the life raft at 2025 NDT.

The ship was enroute to Twillingate at 2030 NDT and secured at the dock at 2135 NDT. The data were downloaded without incident.

Dr. Arthur Allen, of the USCG R&D Center, Groton, Connecticut and Mr. Mario Godinez, a NORDCO Limited computer programmer, arrived to join the ship at 2300 NDT. M. Godinez immediately proceeded to investigate the computer lock up problem that had been experienced.

Tuesday, August 22, 1989

The ship departed Twillingate at 0858 NDT. All equipment was initialized in the usual manner while enroute to the experimental site. Run R05 began when the life raft and a LORAN-C buoy were released at 1017 NDT. The drift run continued until 1853 NDT at which time the life raft was recovered. The program to process LORAN-C time difference data functioned quite well throughout the run R05. Upon return to Twillingate at 1950 NDT, the data were successfully downloaded and subsequently archived to floppy diskettes. Following that, M. Godinez worked on the position program to increase its utility by expanding its graphics zoom capability.

Wednesday, August 23, 1989

The vessel remained in port throughout the day. The monthly crew change took place at noon. Strong northerly winds and relatively heavy seas precluded the conduction of experiment drift runs in the afternoon. In addition, the Canadian East Coast LORAN-C chain (GRI 5930) was scheduled to be turned off from 1530 to 1630 NDT.

M. Godinez continued his efforts to improve the position program. Specific aspects of the program were discussed with Dr. Allen, whose comments and suggestions were greatly appreciated.

Thursday, August 24, 1989

The CCGC "Hood" departed Twillingate at 0800 NDT in a light northerly wind and decaying swell. Run R06 began at 0927 NDT with the deployment of the drogued life raft and a LORAN-C buoy. The drift run was managed in the usual manner until 1820 NDT when the life raft was recovered. The ship was enroute Twillingate at 1830 NDT and arrived at the government wharf at 1935 NDT. Allen and Godinez departed Twillingate for Gander by rental car shortly afterward. All the data files were successfully downloaded in the evening.

Friday, August 25, 1989

Having departed Twillingate at 0830 NDT in moderate to strong southwesterly winds, run R07 was started at 0912 NDT in the usual manner. Following customary practice, the LORAN-C buoys were kept relatively close to the life raft throughout the run. Time difference cycle jumps were not being handled properly by the position monitoring program and it was necessary to restart the program at times to solve the problem. The run ended at 1815 NDT. Upon arriving in Twillingate at 1905 NDT, the data files were downloaded and archived. All the data for the run appeared to be in good condition.

Saturday, August 26, 1989

The chief engineer made repairs to a leaking engine cooling water pipe flange in the morning. The ship departed Twillingate at 1255 NDT in order to carry out drift run R08. The run began at 1406 NDT and ended at 1840 NDT. Winds were light and somewhat variable in direction during run R08. The significant wave height ranged from 1.6 to 2.0 m. The ship arrived back in Twillingate at 1925 NDT. The data files were once again downloaded and archived in the evening.

Sunday, August 27, 1989

The ship left Twillingate at 0810 NDT. Off Twillingate, strong westerly winds of 25 to 30 kts and significant wave heights of 2 m prevailed. Conditions were monitored for approximately one hour. In collabration with Captain Rendell, it was decided that the launching and recovery of the gear would be a risk to both personnel and equipment. The ship returned to Twillingate shortly before mid-day and remained there throughout the remainder of the day.

Monday, August 28, 1989

At 0630 NDT, the CCGC "Hood" departed Twillingate. Run R09 began at 0839 NDT and was conducted in the usual manner. With decreasing winds, it was decided to remove the drogue from the life raft. This was done using the ship's rigid hull inflatable runabout at 1500 NDT. The life raft was recovered at 1802 NDT. The ship returned to Twillingate in the early evening. All the buoy data were downloaded successfully. The life raft wind data file could not be downloaded, although numerous attempts were made. The work day ended at 2300 NDT.

Tuesday, August 29 ,1989

A SAR call was received at 0440 NDT. The CCGC "Hood" departed Twillingate in response to the call at 0505 NDT, after loading the LORAN-C buoys on the wharf. At 0955 NDT, the ship arrived back in Twillingate escorting the longliner F/V Ocean Gambler II. In the morning, after several telephone calls to a NORDCO Limited programmer in St. John's, it was decided to download the memory image of the unit (program files and data file) to a microcomputer, saving it for unpacking and decoding at a later date. The problem is discussed further in Section 2.9.

The CCGC "Hood" departed Twillingate at 1330 NDT in order to carry out drift run R10. The run began at 1433 NDT with the deployment of an undrogued four-person life raft. The run ended at 1825 NDT with the recovery of the life raft. The ship returned to Twillingate at 2010 NDT. In the customary manner, the drift run data were assembled and filed in the evening.

Wednesday, August 30, 1989

In the early morning, the commanding officer received a request from the Marine Rescue Sub-Centre in St. John's to render assistance to a distressed fishing vessel. The NORDCO Limited equipment was lifted ashore and the vessel departed at 0420 NDT. The fishing vessel was in tow at 0850 NDT. It was towed to La Scie where it was released at 1728 NDT. The CCGC "Hood" arrived back in Twillingate at 2128 NDT. Two NORDCO Limited personnel had remained on board the ship, the third individual stayed ashore to look after the equipment that had been left on the wharf.

Thursday, August 31, 1989

R. Fitzgerald, J. Russell, and D. Finlayson departed Twillingate at 0900 NDT for St. John's. Since the field party was to return in seven days time, it was not necessary to remove instrumentation, computers, and so forth from the ship. The after deck was, however, cleared of all project gear. This gear was stored in the adjacent warehouse onshore. The NORDCO Limited group arrived back in St. John's at 1600 NDT.

Friday, September 01 to Thursday, September 07, 1989

During the week, a modified data logging routine was written to record the wind velocity and heading data measured at the life raft. The sample period remained the same (250 milliseconds (ms)). The sampling rate was changed to once per second for a 10 s period for each of the three parameters. The cycle was repeated once every 2 min. Further work was done on the position program to enable it to manage time difference cycle jumps correctly.

Friday, September, 08, 1989

After ensuring that all necessary equipment was packed, R. Fitzgerald, J. Russell, and D. Finlayson departed from St. John's at 1140 NDT by private vehicle. The field party arrived in Twillingate at 2030 NDT

Saturday, September 09, 1989

All required equipment that was stored in the warehouse was moved to the vessel and an improvement was made to the lifting net in an effort to reduce the chances of snagging and damaging the life raft anemometer. A full test was made of the life raft anemometer/compass data logging system. A test of the position program showed that it was not functioning properly. The problem was determined to be related to the changes that had been made for testing purpose when the cycle jump handling routine was modified; it was quickly remedied.

The CCGC "Hood" departed Twillingate at 1410 NDT in very light wind conditions. The life raft and a LORAN-C buoy were deployed at 1503 NDT, beginning run R11. Winds ranged from south-southwest 5 to 15 kt and the significant wave height was near 0.4 m during the run. The run ended at

1822 NDT with the recovery of the life raft. Following the run it was noticed that the wind speed recorded at the life raft appeared to be low. An examination of the propeller assembly indicated that the start threshold was quite high and that there was a considerable amount of friction in the bearing. These wind data for the run are therefore suspect.

The ship arrived back in Twilligate at 1852 NDT. The data recorded and stored in the LORAN-C buoys appeared to be of high quality.

Sunday, September 10, 1989

The life raft anemometer bearing was lubricated resulting in an immediate improvement to its normal state. The ship departed Twillingate at 0800 NDT. Run R12 was started at 0928 NDT in light winds and calm waters. Winds picked up to moderate northeasterly winds in the afternoon. The lift raft was recovered at 1855 NDT, ending run R12. A course was set for Twillingate at 1837 NDT. The ship was secured at 1915 NDT. The buoy data downloaded to the microcomputer appeared to be in excellent condition.

Monday, September 11, 1989

After loading seven 22.7 kg life raft ballast bags on board, the CCGC "Hood" departed Twillingate at 0805 NDT. The ballast bags were added to the life raft to increase the loading to simulate four persons rather than just two individuals. The life raft and one of the LORAN-C buoys were deployed at 0930 NDT to start run R13. Light winds prevailed until 1600 NDT when an apparent frontal passage resulted in winds shifting into the north-northeast and increasing to 15 to 20 kts. At 1630 NDT a small longliner came alongside the CCGC "Hood" to state that it was taking on a considerable amount of water and to request the loan of a portable pump. Run R13 was ended prematurely in order that the CCGC "Hood" could follow the longliner to ensure the safety of the vessel. The first buoy was recovered at 1700 NDT; after recovering the life raft at 1733 NDT, a course was set for Twillingate. The ship was secured at 1945 NDT and the position, wind and heading data were downloaded as usual.

Tuesday, September 12, 1989

The CCGC "Hood" was not available for project work. A water leak in the port main engine had developed: cooling water was being heated into steam and being vented into the engine room. A representative for Caterpillar diesel was requested to examine the nature and seriousness of the problem. The representative arrived late in the afternoon but was unable to provide an immediate assessment.

Wednesday, September 13, 1989

Much of the day was spent awaiting a decision regarding what action was to be taken regarding the port engine. At 1600 NDT, apparently based on advice from Caterpillar representatives, the vessel was declared fully operational by the regional office in St. John's.

Thursday, September 14, 1989

The ship departed Twillingate at 0815 NDT enroute to the wave buoy mooring location. At 0935 NDT the vessel was stopped alongside the mooring to assess the feasibilty of recovering the buoy and mooring. Wind and sea conditions were such that no recovery was attempted. It was felt important to recover the gear at the earliest opportunity to avoid a major logistical problem should the CCGC "Hood" become unservicable.

The life raft and a LORAN-C drifting buoy were deployed at 1051 NDT to begin run R14. The drift objects moved relatively rapidly toward the southeast throughout the day and by mid-afternoon the equipment was fairly close a group of islands known as The Rags. Recovery operations began at 1520 NDT for subsequent re-deployment further to the north. As the life raft was being recovered, the ship was assigned a SAR case. A fishing vessel with steering gear problems required towing from the Grey Islands, off the Great Northern Peninsula. As the case was not an emergency, the CCGC "Hood" was then taken to Twillingate to off load the project gear that was normally stowed on deck. The ship arrived in Twillingate at 1630 NDT. The run R14 data were downloaded as usual and the gear put ashore. The ship departed Twillingate at 2000 NDT in order to arrive at the Grey Islands at first light. Later, the SAR case was cancelled and the CCGC "Hood" returned to Twillingate at 2257 NDT.

Friday, September 15, 1989

The life raft, LORAN-C buoys, and mooring recovery equipment were loaded back aboard the CCGC "Hood". The ship left the wharf at 0815 NDT, once again bound for the wave buoy mooring position. While in transit, the buoys were initialized in the usual manner. The buoy (B22)in the life raft did not respond normally and could not be initialized. The vessel was alongside the wave buoy mooring at 0930 NDT. The zodiac inflatable craft was launched in order to recover the waverider buoy from the mooring. The buoy and boat were recovered at 0958 NDT. The mooring recovery began at 1000 NDT and stopped at 1127 NDT to allow hydraulic oil in the hoisting equipment to cool. Recovery recommenced at 1207 NDT. The three railway wheel anchor was lifted aboard completing the recovery at 1250 NDT.

Since the buoy in the life raft was not operational, it was decided to return to Twillingate to change out the buoy and unload the wave buoy and mooring equipment. The ship arrived back in Twillingate at 1425 NDT. The work to change out the LORAN-C buoy was begun immediately and the mooring gear was put ashore. The life raft was ready for service at 1630 NDT but it was considered too late in the day to commence a drift run.

Saturday, Sepember 16, 1989

The CCGC "Hood" departed Twillingate at 0810 NDT. Strong northwesterly winds prevailed outside the harbour. The life raft was set adrift at 0936 NDT, the start of run R15. The winds veered and decreased throughout the day to become light easterly by the end of the run. The life raft was alongside the ship at 1814 NDT. It was recovered and the ship was enroute to Twillingate at 1831 NDT. After tying up at 19[illegible]0 NDT, the data were then downloaded and archived.

Sunday, September 17, 1989

The ship departed Twillingate at 0805 NDT to conduct the final drift run of the experiment. Run R16 was started at 0912 NDT and was ended at 1530 NDT. The ship then returned to Twillingate where all project equipment was stripped from the ship and stowed ashore in the warehouse for packing the following morning. It was felt important to remove all of the gear as quickly as possible to avoid logistical difficulties in the event of a SAR mission. The work was complete by mid-evening.

Monday, September 18, 1989

R. Fitzgerald departed for Gander by private vehicle at about 0700 NDT to pick up a truck at a rental agency. In the meanwhile, all project instrumentation and equipment was packed for transport. Loading began immediately upon the arrival of the truck, the ship's crane being used for the heavier components of the mooring gear. R. Fitzgerald, J. Russell, and D. Finlayson departed Twillingate at mid-day and arrived in St. John's by mid-evening. The equipment was unloaded the following day.

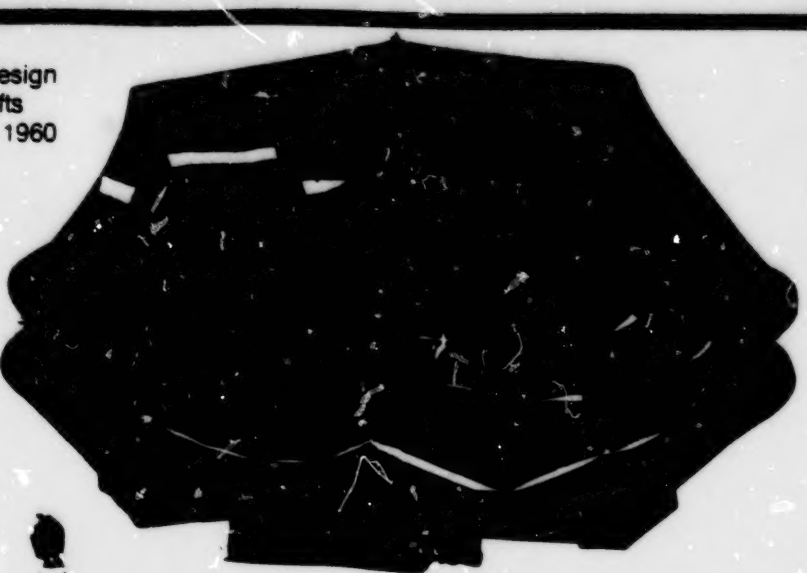
REFERENCES

Department of National Defence and Canadian Coast Guard, 1985, National Search and Rescue Manual. Department of National Defence No. B-GA-209-001/FP-001, Canadian Coast Guard No. TP5421, Ottawa.

APPENDIX C

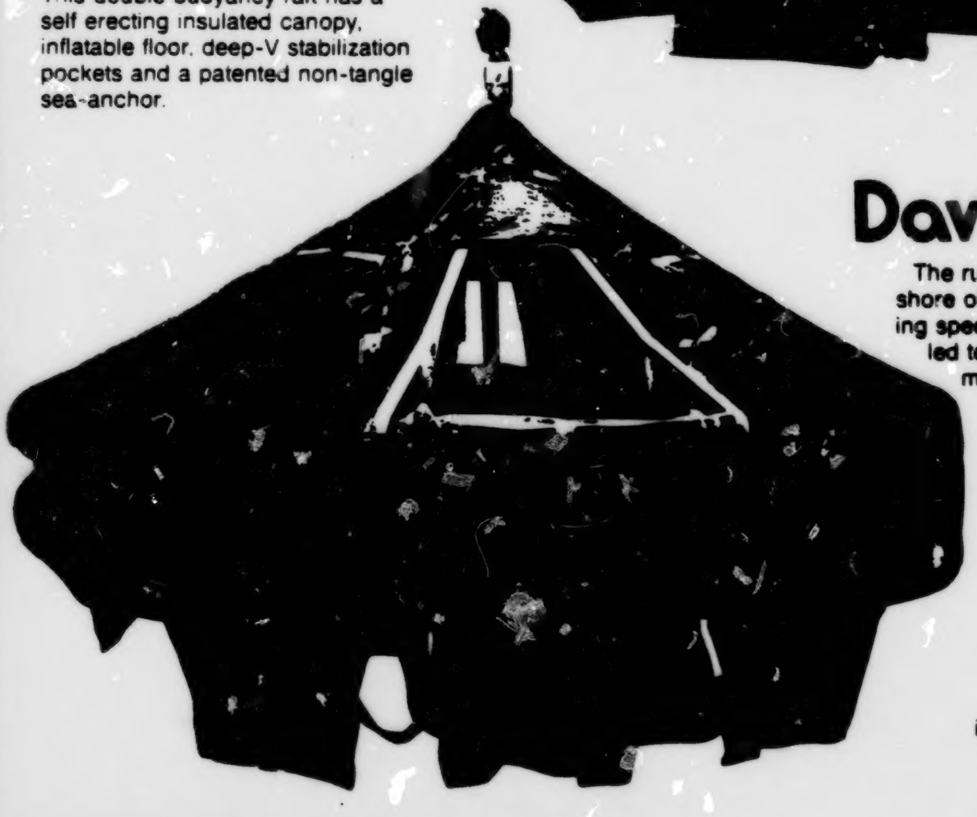
LIFE RAFT PARTICULARS

Beaufort has been involved in the design and development of inflatable liferafts for over twenty-five years. Since the 1960 SOLAS convention, Beaufort rafts have been fitted on cruise ships, naval vessels and merchant ships throughout the world.



RBM Series

Solas, U.S. and Canadian Coast Guard approved, this remarkably sturdy liferaft comes in sizes ranging from 4 to 25 persons. This double buoyancy raft has a self erecting insulated canopy, inflatable floor, deep-V stabilization pockets and a patented non-tangle sea-anchor.

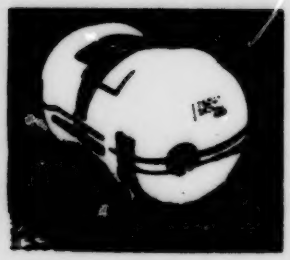


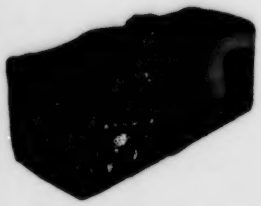
Davit Series

The rugged demand of the off-shore oil industry and the exacting specifications of cruise ships led to the development of this multi-purpose raft. Deep-V stabilization pockets, double buoyancies, self erecting canopy, inflatable floor and patented non-tangle sea-anchor provide safety and comfort.

Unique feature:

Double layer in canopy fills automatically, providing immediate and additional insulation plus extra comfort to survivors.





Optional equipment includes a choice of stowage and various emergency packs as specified overleaf.

Service stations in most major North American ports.

Beaufort

APPROXIMATE WEIGHT AND DIMENSIONS OF CONTAINERS

TYPE RBM APPROVED LIFERAFT	BASIC	SOLAS, CSI 'B' PACK	ORS RACING PACK	SOLAS, CSI 'A' PACK	U.S.C.G. FULL OCEAN SERVICE
	WEIGHT DIMENSION	WEIGHT DIMENSION	WEIGHT DIMENSION	WEIGHT DIMENSION	WEIGHT DIMENSION
4 Person					
Valise	23 kg 71 × 31 × 31 cm 53 lbs 28 × 12 × 12 in		29 kg 74 × 31 × 31 cm 64 lbs 29 × 12 × 12 in		
Flat container	29.5 kg 79 × 48 × 31 cm 65 lbs 31 × 19 × 12 in		34.5 kg 84 × 56 × 33 cm 76 lbs 33 × 22 × 13 in		
Round container		34.5 kg 76 × 51 cm dia 76 lbs 30 × 20 in dia		54.5 kg 87 × 51 cm dia 120 lbs 34 × 20 in dia	54.5 kg 87 × 51 cm dia 120 lbs 34 × 20 in dia
6 Person					
Valise	27 kg 74 × 31 × 31 cm 59 lbs 29 × 12 × 12 in		33.5 kg 92 × 38 × 31 cm 74 lbs 36 × 15 × 12 in	59 kg 84 × 46 ×43 130 lbs 33 × 18 × 17 in	
Flat container	32 kg 84 × 56 × 33 cm 71 lbs 33 × 22 × 13 in		39 kg 94 × 59 × 36 cm 86 lbs 37 × 23 × 14 in		
Round container		39 kg 87 × 51 cm dia 86 lbs 34 × 20 in dia		71.5 kg 102 × 54 cm dia 157 lbs 40 × 21 in dia	71.5 kg 102 × 54 cm dia 157 lbs 40 × 21 in dia
8 Person					
Valise	34 kg 74 × 31 × 31 cm 75 lbs 29 × 412× 12 in		43 kg 92 × 43 × 31 cm 94 lbs 36 × 17 × 12 in	72 kg 84 × 46 × 43 cm 159 lbs 33 × 18 × 17 in	
Flat container	41.5 kg 94 × 59 × 36 cm 91 lbs 37 × 23 × 14 in		50 kg 74 × 51 cm dia 110 lbs 29 × 20 in dia		
Round container		50 kg 102 × 54 cm dia 110 lbs 40 × 21 in dia		84 kg 107 × 59 cm dia 185 lbs 42 × 23 in dia	84 kg 107 × 59 cm dia 185 lbs 42 × 23 in dia
10 Person Round container		80 kg 107 × 59 cm dia 176 lbs 42 × 23 in dia		98 kg 117 × 64 cm dia 216 lbs 46 × 25 in dia	[illegible] kg 117 × 64 cm dia 216 lbs 46 × 25 in dia
12 Person Round container		142 kg 107 × 64 cm dia 312 lbs 46 × 25 in dia		114 kg 127 × 69 cm dia 251 lbs 50 × 27 in dia	
16 Person Round container		142 kg 117 × 64 cm dia 312 lbs 46 × 25 in dia		144 kg 127 × 69 cm dia 317 lbs 50 × 27 in dia	144 kg 127 × 69 cm dia 317 lbs 50 × 27 in dia
20 Person Round container		147 kg 127 × 69 cm dia 324 lbs 50 × 27 in dia		160.5 kg 140 × 76 cm dia 353 lbs 55 × 30 in dia	
25 Person Round container		147 kg 127 × 69 cm dia 324 lbs 50 × 27 in dia		181.5 kg 140 × 76 cm dia 399 lbs 55 × 30 in dia	181.5 kg 140 × 76 cm dia 399 lbs 55 × 30 in dia
25 Person **DAVIT LAUNCH** Round container				181.5 kg 140 × 76 cm dia 399 lbs 55 × 30 in dia	

All rafts include BASIC EQUIPMENT: sea anchor, rescue line and quoit, safety knife, baler, paddles, foot pump, repair kit, sponges, survival instruction card and signal card.

'A' PACK INCLUDES: basic equipment plus first aid kit, 1½ litres drinking water per person, drinking cup, 3 can openers, ½ kg food per person, fishing tackle, flashlight with spare bulb and batteries, signalling mirror, signal whistle, 2 parachute rockets, 6 hand flares and sea-sickness tablets.

'B' PACK INCLUDES: basic equipment plus 6 flares and flashlight with spare batteries and bulb.

FOS PACK (Full Ocean Services) INCLUDES: 'A' Pack plus hydrostatic release.

RACING PACK INCLUDES: Basic equipment plus 2 parachute rockets, 3 hand flares, first aid kit, ½ litre drinking water per person, drinking cup, sea-sickness tablets, 2 can openers, flashlight with spare bulb and batteries.

Talk to us about variations on the above optional equipment or other modifications.

Beaufort

Beaufort Air-Sea Equipment

IN THE U.S.: P.O. Box 80504
Seattle, Washington, 98108,
Telephone (206) 762-2710

IN CANADA: 12351 Bridgeport Road,
Richmond, B.C.,V6V 1J4,
Telephone (604) 278-3221

Represented by:
ATLANTIC INDUSTRIAL AND
MARINE SUPPLIES LTD
P. O. Box [illegible]
NEWFOUNDLAND [illegible]
709-3[illegible]8-A[illegible]S
709-338-0[illegible]23

APPENDIX D

LORAN - C DRIFTER BUOY SPECIFICATIONS

candel
INDUSTRIES LIMITED

Loran-SEA ROVER

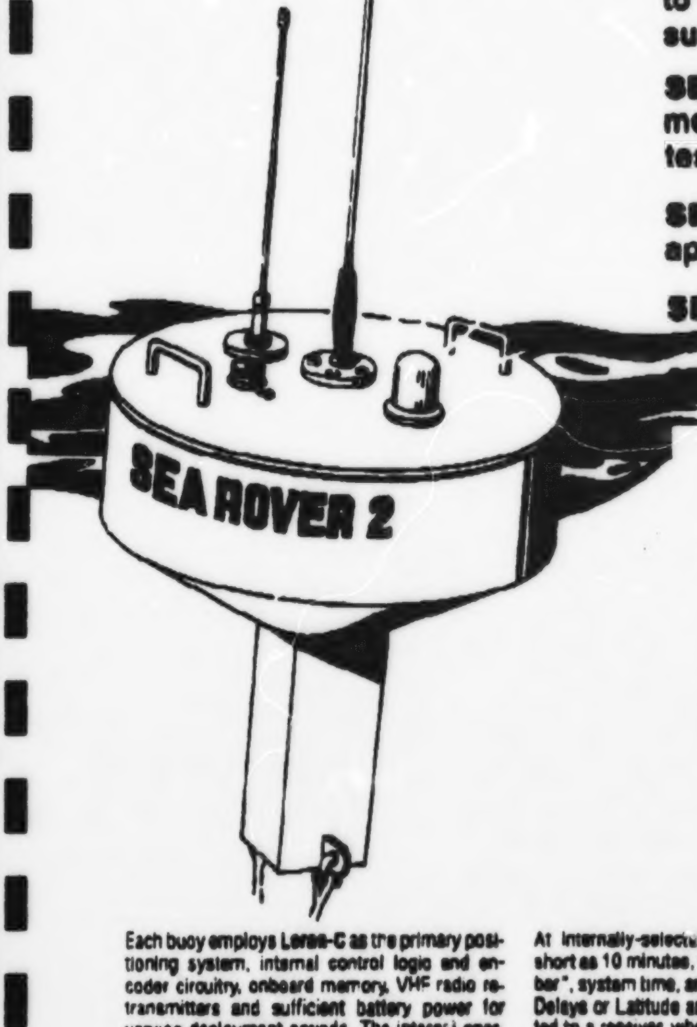
DRIFTING CURRENT BUOYS

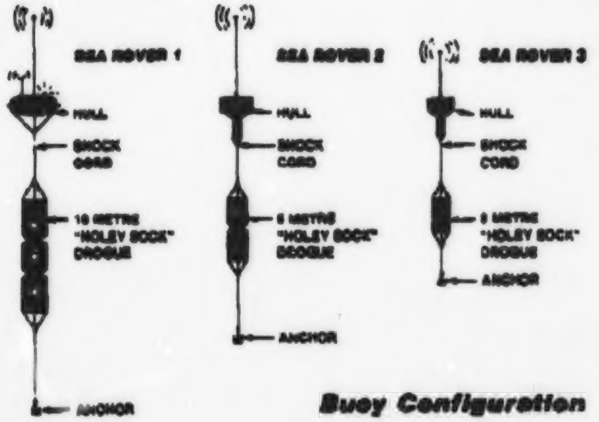
Loran-SEA ROVER Drifting Current Buoys employ state-of-the-art technology to acquire real-time Lagrangian current measurements in three states of wave activity.

SEA ROVER 1 is designed for measurement of open ocean currents, and has been tested in seas of near 10 metres.

SEA ROVER 2 is designed for coastal applications, where seas approach 5 metres.

SEA ROVER 3 is intended for near-shore current measurements, in less severe sea conditions.





Buoy Configuration

Each buoy employs Loran-C as the primary positioning system, internal control logic and encoder circuitry, onboard memory, VHF radio retransmitters and sufficient battery power for varying deployment periods. The internal operations of each model are identical and will produce data of equal resolution and quality.

At internally-selectable sampling intervals, as short as 10 minutes, a "Buoy Identification Number", system time, and the buoy's position (Time Delays or Latitude and Longitude) are transmitted to a receiver, where the signal is decoded to RS232 format and made available to any computing/storage system.

The data produced by Loran-SEA ROVER are superior to satellite-tracked buoys, and are equally spaced in time with fix positions of 0.1 uSec. in time delays, or about 30 metres in position. The fine temporal and geographic resolution permits quantification of current features, two orders of magnitude smaller than possible with satellite buoys.

SPECIFICATIONS (ALL MODELS)

Loran-C

SENSITIVITY	1 microvolt/m.
RESOLUTION	0.1 uSec. = ± 30 metres.
DYNAMIC RANGE	105 dB.
SETTLING TIME	1 minute.
CHAIN SELECTION	Manual, for world-wide GRI's.
SLAVE ACQUISITION	Automatic for GRI selected.

Receiver/Recorder

SENSITIVITY	0.35 uV for 20 dB SINAD
ANTENNA	3 dB gain, 5/8 wave, fiberglass, with loading coil.
DEMODULATOR AND INTERFACE	Two-tone FSK demodulator, phase lock loop, RS232 ASCII encoded output.
POWER SUPPLY	110v, 60 Hz VAC

Controller/Memory

TRANSMIT INTERVAL	Selectable in 10-minute increments to 100 minutes.
DATA MESSAGE REPETITION	Selectable 1 to 10 times per transmission.
BUOY I.D. NUMBER	Selectable 0 to 99.
MEMORY CAPACITY	to 64K Bytes in 8K increments. Standard 32K Bytes is sufficient for about 2 month's data at half-hourly sampling.

VHF Retransmitter

R.F. POWER OUTPUT	75 watts maximum.
TRANSMISSION RANGE	70 nautical miles.
SPURIOUS AND HARMONIC EMISSIONS	Approximately -70 dB.

MECHANICAL SPECIFICATIONS

	Loran-SEA ROVER 1	Loran-SEA ROVER 2	Loran-SEA ROVER 3
HULL	Ellipsoidal RHOME glass-reinforced plastic. Dimensions: 112 cm x 60 cm. Weight, with batteries: Approximately 70 kg. Batteries: Alkaline lantern batteries, capacity 160 Ah. Antenna: 254 cm, fiberglass whip. Transmit Range: Approximately 70 nautical miles.	"Light Bulb", high quality welded aluminum. Dimensions: 60 cm x 85 cm. Weight, with batteries: Approximately 34 kg. Batteries: Alkaline lantern batteries, capacity 65 Ah. Antenna: 254 cm, fiberglass whip. Transmit Range: Dependent on transmitter selected.	"Light Bulb", high quality welded aluminum. Dimensions: 30 cm x 45 cm. Weight, with batteries: Approximately 20 kg. Batteries: Alkaline lantern batteries, capacity 30 Ah. Antenna: 127 cm fiberglass whip. Transmit Range: dependent on transmitter selected.
DROGUE	Nylon "Holey Sock". Dimensions: 10 metres X 1 metre. Shock Cord: Compliant Bungi cord, 10 metres unstretched.	Nylon "Holey Sock". Dimensions: 5 meters x .75 meters. Shock Cord: Compliant Bungi cord, 5 metres unstretched.	Nylon "Holey Sock". Dimensions: 2 meters x .5 metre. Shock Cord: Compliant Bungi cord, 2 metres unstretched.

OPTIONS AVAILABLE

XENON STROBE LIGHT	4 quick flashes, 16-second occultation. Photo-sensitive, 0.15 watt/second power input. Current drain: Approx. 15 milliamp. Visible Range: 1-2 miles.
AC or DC POWERED RECEIVER	AC input: 50-200 VAC. 0.6 Amp maximum. DC input: 8-5 VDC. 50-400 Hz
RADIO TRACKING BEACON AND DIRECTIONAL RECEIVER	¼ wave antenna. 200 milliwatt output. DOC/FCC-approved. Range: 6-8 miles Hand-held receiver. Left-right indicator.
RECHARGEABLE RECEIVER BATTERIES	Internal rechargeable Gel-Cell Batteries. Approximately 12 hours operation.

Manufactured by

candel
INDUSTRIES LIMITED

P.O. Box 2580, Sidney, British Columbia Canada V8L 4C1 (604) 656-0188

Made in Canada

candel
INDUSTRIES LIMITED

PO Box 2580, Sidney, British Columbia, Canada V8L 4C1
Offices: 1974 Mills Road Telex: 049-7528 Telephone: (604) 656-0156

SEA ROVER 3 LORAN-C BASED DRIFTING BUOY SPECIFICATIONS

Candel Industries Ltd.
MARINE SERVICES DIVISION
P.O. Box 2580
1974 Mills Rd.
Sidney, B.C.
V8L 4C1

October 6, 1988

The following SEA ROVER 3 specifications detail mechanical and operational enhancements over all previous buoys. All specifications relating to Loran-C operation and specifications such as Sensitivity, Resolution, etc. remain as detailed within previous brochures.

MECHANICAL CONFIGURATION

8 inch Pressure Case. All electronics are housed within the top section of an 8 inch pressure case. All batteries are housed in the lower section of the pressure case separated from the electronics by a water tight bulkhead and connector.

Upper End Cap. The Upper End Cap of the buoy provides an external oceanographic connector for monitoring and retrieving internal operational parameters and stored data. In addition two switches are provided below protective caps, ON/OFF and TEST TRANSMISSION. All mechanical mountings for the antenna, handles and securing hardware are found on the Upper End Cap.

Removable Buoyancy Ring. A removable Buoyancy Ring has been provided which provides not only the necessary buoyancy for floatation but also adds the convenience of being easily removed for shipment or lab work.

Real Time Clock. All data transmission and internal recording are referenced to a real time clock.

.../2

Standard 56K Memory is provided for storage of both positional data and data from up to six additional analog sensors. All stored data will be stamped with a unique identity number of the buoy and the resulting position and optional analog sensor data.

Switch Selectable Transmission Formats will enable the buoys to transmit in either the old (SEA ROVER 1 and SEA ROVER 2) format or a new REED SOLOMON Forward Error Correction Format.

SOFTWARE CONFIGURATION

Logic contained within the SEA ROVER 3 ensures an efficient data manipulation and recovery scheme which is "User Friendly".

The software and control logic include the following features:

Non Volatile System Storage. All variable input data such as Group Repetition Intervals, Transmission Rates and Transmission Repetition Rates, are input via any RS232 communication device. All system variables are held within non-volatile battery backed RAM. An onboard battery enables this data to be input under lab conditions and transported to the field without main system batteries. Installing main batteries, testing and deploying the buoy can be accomplished without entering the system storage information. An external connector enables modification of this information via any typical RS 232 device at any time.

Time Stamped Data. All data, either recorded or transmitted, has as part of that record, a real time stamp. This stamp is in the typical PC format as a four byte figure representing the number of seconds elapsed since January 01,1970.

Transmit Intervals Transmit Intervals in minutes, have been provided which enable collection of data on any interval which is evenly divided into one day. This permits collection of data at rates as small as once per minute or as large as once per day.

Repetition Counts. On the occurance of each Transmit Interval, the resulting data may be transmitted as few as once or as many as ten times. This will increase the probability of data reception at longer ranges or noisy environments.

Staggered Transmission Intervals, will ensure that no two buoys transmit during the same, typically 10 second, transmission slot. These intervals are referenced to a user input buoy identification number. Each digit of the ID number will offset transmission by 15 seconds. Data is collected and either stored within memory or held within a buffer until the correct transmission slot has occurred. Data is collected simultaneously by all buoys, and transmitted at staggered intervals.

RS232 and RF Transmitted Data, All data transmitted by the buoy via VHF communications will also be communicated via the RS232 connector. This enables verification of transmitted data, by comparing it against that being stored.

Error Detection/ Transmission Format. Two individual data transmission formats are available, selection between which is provided by internal switch. The first format is that format used by previous SEA ROVER 1 and SEA ROVER 2 buoys. This transmission format will enable all three types of buoys to be used on the same project. The second format employs a Reed Solomon Forward Error Detection Format. This format will ensure correctness of both transmitted and received data. Error detection logic is provided in both the buoy and the receiver. The receiver will decode the incoming data and label that data as being correct or in error.

Unique Message Format. In addition to the typical Time Differences calculated from up to 4 Loran-C Slave stations, the output data message includes Signal to Noise Ratios for each Slave and Master, Internal Battery Voltage, Optional Sea Surface Temperature, Real Time, Error Correction Indicators, and a Check Sum of each transmission.

RECEIVER 2 CONFIGURATION

The RECEIVER 2 has been designed to make efficient use of the new data transmission/ error detection format. Following are hardware and software features of the RECEIVER 2:

Signal Strength Meter. Indication of the received signal strength from each buoy is provided via a case mounted analog meter. It is now easier to define which buoy transmits the strongest signal and which are likely to be lost as a result of signals becoming weak at extended ranges.

AC or DC Powered. All RECEIVER 2 electronics can be supplied power from either external 90 to 220 VAC or 8 to 40 VDC, or from an internal rechargeable battery pack. This feature will enable use from small launches, or from remote shore stations.

Duplicate Control Card. An identical Control Card to that used within each buoy provides error detection circuitry, onboard memory, signal strength driver circuitry and the ability to communicate with each buoy through VHF communications.

Rechargeable Battery Pack. Rechargeable batteries are employed which provide 24 hours of continuous DC operation. Provision for recharging have been made via external connection.

APPENDIX E

WIND MONITORING SYSTEM

YOUNG

R.M. YOUNG COMPANY
2801 Aero-Park Drive, Traverse City, MI 49684, U.S.A.
Phone (616) 946-3980 TWX 810-291-3366

INSTRUCTIONS

WIND MONITOR - MODEL 05102

☑ WIND MONITOR
  - GENERAL
  - OPERATING PRINCIPLE
  - CALIBRATION
  - EXPOSURE AND ORIENTATION
  - MAINTENANCE
  - PROPELLER CALIBRATION CURVES
  - SENSOR ASSEMBLY & REPLACEMENT PARTS
  - CABLE CONNECTIONS

☑ D/A SENSOR INTERFACE CARD

☐ WS/WD INDICATOR

☐ RECORDER-TRANSLATOR

☑ CALIBRATION UNIT

☐ ____________________

SEP 83

R. M. YOUNG COMPANY
TRAVERSE CITY. MI 49684 U.S.A.

AUGUST 1984

ENGINEERING CHANGE NOTICE - WIND MONITOR MODEL 05102 AND MODEL 05101

PROPELLER SHAFT BEARING CLEARANCE INCREASED FROM 0.1 MM (0.004") TO 0.5 MM (0.020")

ON WIND MONITOR MODELS 05102 AND 05101 IT HAS BEEN FOUND THAT HIGH SUMMER TEMPERATURES MAY CAUSE A GREATER DIFFERENTIAL EXPANSION OF COMPONENTS IN THE NOSE CONE ASSEMBLY (PART NO. 05160A/05160) THAN THE PRE-SET BEARING CLEARANCE. THIS MAY RESULT IN EXCESS LOADING OF THE PROPELLER SHAFT BEARINGS (PART NO. 05163) CAUSING PREMATURE FAILURE.

ON ALL WIND MONITOR INSTALLATIONS IN WARM CLIMATES SUBJECT TO TEMPERATURES ABOVE 30 C° (86° F) AND DIRECT SUN IT IS RECOMMENDED THAT THE PROPELLER SHAFT BEARING GAP BE INCREASED TO 0.5 MM (0.020"). BEARING GAP IS EASILY ADJUSTED BY LOOSENING THE 3-48 SET SCREW IN THE MAGNET & SHAFT COLLAR (PART NO. 05161A/05169) AND RE-POSITIONING THE MAGNET ON THE SHAFT. TO AID IN MAKING THIS CHANGE A 0.5 MM (0.020") GAUGE IS ENCLOSED.

PLEASE MAKE A NOTE OF THIS CHANGE IN THE INSTRUCTION MANUAL FOR THE INSTRUMENT.

AFTER ADJUSTMENT AND REASSEMBLY HOLD THE MAIN HOUSING AND ROTATE THE MOUNTING POST THROUGH COMPLETE 360° ROTATION. WATCH PROPELLER FOR ANY INDICATION OF CONTACT BETWEEN MAGNET AND COIL. MAGNET MUST NOT COME IN CONTACT WITH COIL IN ANY POSITION.

Applies to model 05103 also

YOUNG

R. M. YOUNG COMPANY SEPTEMBER 1994

MODEL 05103 WIND MONITOR

The fourth major production redesign was completed in July 1984 resulting in a change of designation to Model 05103 Wind Monitor. Model 05103 begins with Serial Number 441. Numerous improvements have been incorporated:

AZIMUTH POTENTIOMETER - 355 degree function angle. 10,000 ohm resistance. (Effective September 1983).

MAIN HOUSING - Injection molded (formerly thermoformed) resulting in more consistent dimensional tolerance and fewer separate parts. Significantly stronger.

HOUSING SKIRT - Flared outward at bottom to provide a better drip edge at the mounting post joint. 30 degree calibration marks added to flared edge of skirt to aid in field check of wind direction calibration.

NOSE CONE ASSEMBLY - Threads into main housing, eliminating need for separate mounting screws. (Effective January 1984).

MOUNTING POST/ORIENTATION RING - Injection molded with stainless steel band clamps for attachment. Corrosion resistant with troublesome set screws eliminated.

JUNCTION BOX - Injection molded with slide cover eliminating separate cover and small screws. Projection provided at cable entry for cable tie. Cable may enter box from externally or may be routed through mounting pipe and mounting post.

PROPELLER SHAFT BEARINGS - Light contacting Teflon seals added to help exclude contamination and moisture. (Slight sacrifice in threshold sensitivity).

POTENTIOMETER COUPLING - Redesigned for better alignment with lower torque. Spring loaded vertically for improved engagement with main housing.

POTENTIOMETER ADJUSTMENT THUMBWHEEL - Adjustment added for ease of potentiometer alignment. Accessible through front of main housing with nose cone removed.

MAIN HOUSING LATCH - Internal latch secures main housing to mounting post-transducer assembly eliminating screws in main housing. Accessible through front of main housing with nose cone removed.

COIL COVER - Plastic cover installed over wind speed pick-up coil to protect coil winding and provide improved dimensional tolerance between magnet and coil.

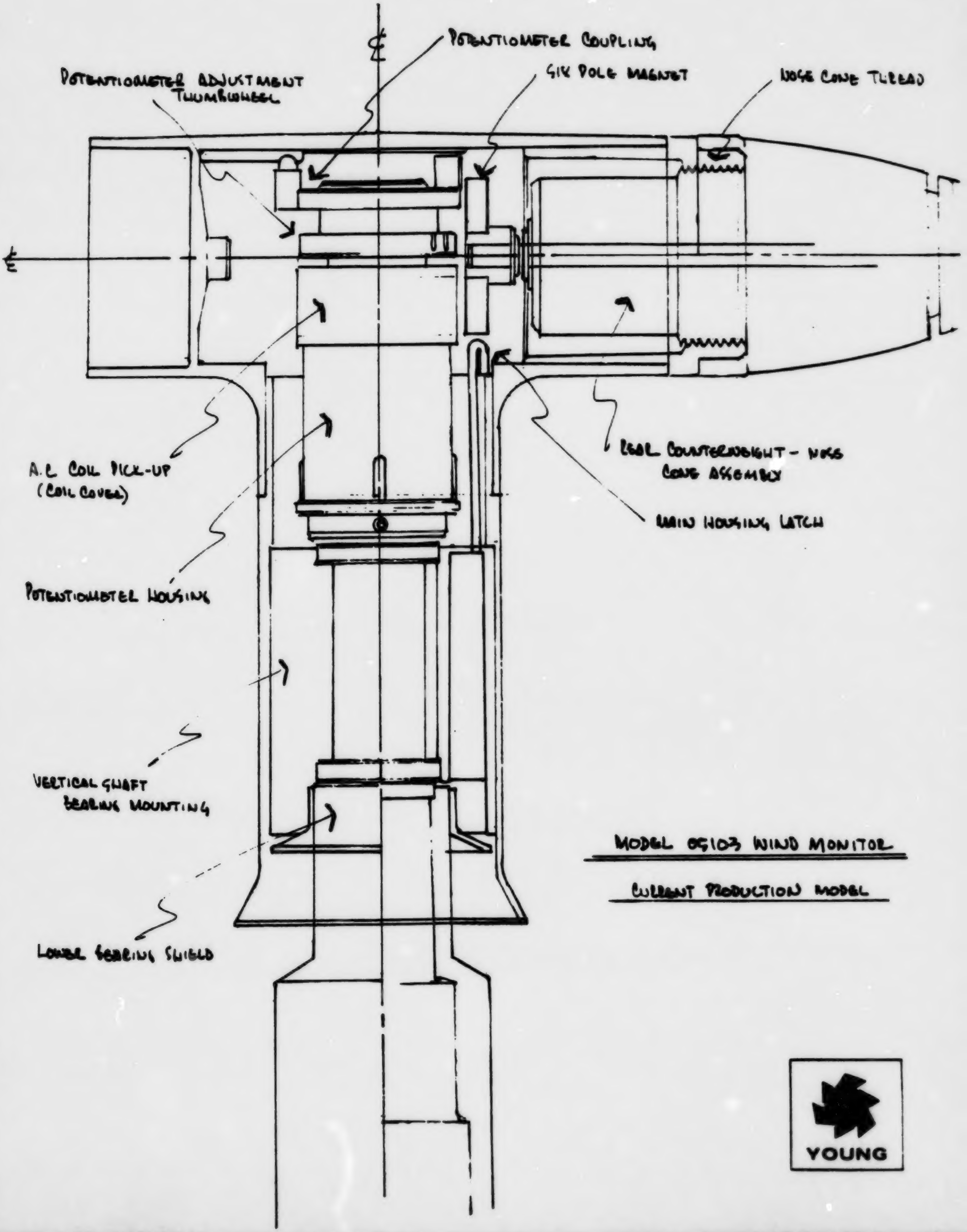
PROPELLER SHAFT/PROPELLER NUT - Larger thread (1/4-20) molded directly on propeller shaft with propeller hub. Larger diameter shaft at outboard end protected with plastic covering. (Thread formerly 8-32 on reduced diameter propeller shaft).

LOWER BEARING SHIELD - Shield added to mounting post directly below lower vertical shaft bearing to help block wind driven contamination and moisture penetration into lower bearing.

INSTRUCTIONS - MODEL 05103 WIND MONITOR
REMOVAL OF MAIN HOUSING

1. Remove nose cone assembly from main housing (right hand thread).
2. Push latch toward center of instrument to release (refer to cross sectional drawing).
3. Holding latch in the released position, push up on the main housing with the other hand.
4. Pull the main housing up and off the mounting post-transducer assembly.
5. During re-assembly, ensure the potentiometer coupling is properly engaged with main housing.

SEPT. 4, 1984


POTENTIOMETER COUPLING
POTENTIOMETER ADJUSTMENT THUMBWHEEL
SIX POLE MAGNET
NOSE CONE THREAD
℄
℄
A.C. COIL PICK-UP (COIL COVER)
REAR COUNTERWEIGHT - NOSE CONE ASSEMBLY
MAIN HOUSING LATCH
POTENTIOMETER HOUSING
VERTICAL SHAFT BEARING MOUNTING
LOWER BEARING SHIELD

MODEL 05103 WIND MONITOR

CURRENT PRODUCTION MODEL

YOUNG

WIND MONITOR MODEL 05102

GENERAL

ORIGINALLY DEVELOPED FOR OCEAN DATA BUOY USE THIS WIND MONITOR IS WELL SUITED FOR A VARIETY OF GENERAL WIND RECORDING APPLICATIONS. SIMPLICITY AND LIGHTWEIGHT CORROSION RESISTANT CONSTRUCTION WERE PRINCIPAL DESIGN CONSIDERATIONS. SLIP RINGS AND BRUSHES HAVE BEEN ELIMINATED RESULTING IN IMPROVED RELIABILITY WITH LOWER COST.

THE WIND SPEED SENSOR IS A HELICOID SHAPE PROPELLER MOLDED OF POLYPROPYLENE PLASTIC. THE PROPELLER IS FOUR BLADE, 18 CM DIAMETER X 30 CM PITCH WITH A DISTANCE [illegible] METERS (10.5 FEET) [illegible] SENSITIVITY OF THE PROPELLER IS 0.3 M/S (0.7 MPH). ROTATION OF THE PROPELLER PRODUCES AN A.C. SINE WAVE VOLTAGE SIGNAL WITH FREQUENCY DIRECTLY PROPORTIONAL TO WIND SPEED. THE A.C. VOLTAGE SIGNAL IS INDUCED IN A CENTRALLY MOUNTED COIL BY A SIX POLE MAGNET MOUNTED ON THE PROPELLER SHAFT. THE COIL IS LOCATED ON THE NON-ROTATING CENTRAL PORTION OF THE MAIN MOUNTING [illegible] ARE [illegible] NEEDED.

THE VANE ASSEMBLY HAS A THRESHOLD SENSITIVITY LESS THAN [illegible] WITH A DAMPING RATIO OF [illegible]. VANE POSITION IS TRANSMITTED THROUGH A COUPLING TO A [illegible] PLASTIC POTENTIOMETER WHICH IS [illegible] CHAMBER IN THE CENTER OF THE MAIN [illegible] WIND SPEED TRANSDUCER COIL. THE POTENTIOMETER REQUIRES A REGULATED EXCITATION VOLTAGE. WITH A CONSTANT VOLTAGE APPLIED TO THE POTENTIOMETER [illegible] THE OUTPUT SIGNAL IS AN ANALOG VOLTAGE [illegible] PROPORTIONAL TO AZIMUTH ANGLE. ALL TRANSDUCER LEADS TERMINATE IN A JUNCTION BOX ON THE MOUNTING POST [illegible] SENSOR CABLE CONNECTIONS. [illegible] REQUIRED.

[illegible] ARE THERMOPLASTIC [illegible] STABILIZED [illegible]. THE NOSE CONE ASSEMBLY [illegible] PARTS ARE INJECTION MOLDED. PROPELLER SHAFT BEARINGS AND THE VERTICAL [illegible] BEARINGS ARE STAINLESS STEEL PRECISION GRADE BALL [illegible].

THE INSTRUMENT MOUNTS ON STANDARD [illegible] INCH IRON PIPE.

OPERATING PRINCIPLE

THE BALANCED VANE ASSEMBLY ROTATES FREELY ON THE VERTICAL SHAFT BEARINGS. THE ANGULAR POSITION OF THE VANE IS TRANSMITTED FROM THE TOP OF THE MAIN HOUSING THROUGH A COUPLING TO THE SHAFT OF THE 10K OHM PRECISION CONDUCTIVE PLASTIC POTENTIOMETER WHICH IS LOCATED INSIDE THE SEALED POTENTIOMETER HOUSING IN THE CENTRAL PORTION OF THE INSTRUMENT. THE POTENTIOMETER SHAFT EXTENSION IS FITTED WITH A SMALL O-RING WHICH SEALS THE SHAFT AT THE POINT THAT IT PASSES THROUGH THE POTENTIOMETER HOUSING.

THE POTENTIOMETER REQUIRES A REGULATED EXCITATION VOLTAGE FROM A BATTERY OR POWER SUPPLY. WITH CONSTANT VOLTAGE APPLIED TO THE POTENTIOMETER THE ANALOG VOLTAGE SIGNAL OUTPUT IS DIRECTLY PROPORTIONAL TO THE AZIMUTH ANGLE OF WIND DIRECTION. THE POTENTIOMETER IS RATED 1 WATT AT 40 DEGREES [illegible] AND DERATED LINEARLY TO 0 WATTS AT 125 DEGREES C, AND CARE MUST BE EXERCISED NOT TO APPLY EXCESSIVE VOLTAGE TO THE ELEMENT NOR TO ALLOW EXCESSIVE CURRENT TO BE DRAWN FROM THE WIPER. MAXIMUM APPLIED VOLTAGE SHOULD NOT EXCEED 26 VOLTS. REGULATED EXCITATION VOLTAGE BETWEEN 5 AND 15 VD.C. IS RECOMMENDED. MAXIMUM WIPER CURRENT SHOULD NOT EXCEED ONE MILLIAMP. THE POTENTIOMETER HAS A 1K RESISTOR INSTALLED ON THE TERMINAL CONNECTION TO THE WIPER. THIS IS A CURRENT LIMITING RESISTOR WHICH HELPS PROTECT THE POTENTIOMETER ELEMENT FROM BURN OUT IN THE EVENT OF MOMENTARY SHORT CIRCUIT OR OVERLOAD.

THE POTENTIOMETER HAS AN OPEN SECTION (DEAD BAND) IN THE ELEMENT OF 5 DEGREES. NORMALLY THE OPEN SECTION OF THE POTENTIOMETER ELEMENT IS ORIENTED TO NORTH AND THIS IS MADE TO CORRESPOND TO THE ZERO LEVEL OF THE [illegible] SIGNAL. THUS ROTATION OF THE VANE FROM NORTH TO EAST TO SOUTH, ETC., WILL CAUSE THE AZIMUTH SIGNAL TO INCREASE TO SUCCESSIVELY HIGHER VALUES UNTIL THE VANE REACHES 355 DEGREES ROTATION AT WHICH POSITION THE SIGNAL FALLS TO ZERO. WHEN ADJUSTING THE FULL SCALE READING IN THE AZIMUTH RECORDER OR DATA [illegible] IT SHOULD BE SET AT 355 DEGREES, OR 5 DEGREES BELOW [illegible] SCALE, RATHER THAN A FULL 360 DEGREES. THIS WILL PROVIDE THE OPTIMUM LINEARITY OVER THE 355 DEGREE ACTIVE ELECTRICAL RANGE OF THE POTENTIOMETER.

THE WIND SPEED SENSING CIRCUIT CONSISTS OF APPROXIMATELY 4000 TURNS OF 36 AWG MAGNET-WIRE WOUND ON A MOLDED PLASTIC BOBBIN. A SIX POLE RING MAGNET MOUNTED ON THE PROPELLER SHAFT INDUCES AN A.C. SINE WAVE VOLTAGE SIGNAL IN THE COIL WINDING WITH A FREQUENCY OF THREE COMPLETE VOLTAGE CYCLES PER PROPELLER REVOLUTION. THE COIL IS MOUNTED CONCENTRICALLY IN THE MAIN HOUSING OF THE INSTRUMENT SO THAT THE MAGNET IS ALWAYS A CONSTANT DISTANCE FROM THE COIL WINDING REGARDLESS OF CHANGES IN WIND DIRECTION. WITH THREE VOLTAGE CYCLES PER PROPELLER REVOLUTION AND WITH 30 CM PROPELLER PITCH EACH COMPLETE VOLTAGE CYCLE REPRESENTS 10 CM OF WIND PASSAGE.

VOLTAGE CYCLES CAN BE COUNTED TO MEASURE TOTAL WIND PASSAGE WITH TIME OR CONVERTED TO AN ANALOG WIND SPEED SIGNAL TO PROVIDE INSTANTANEOUS OR AVERAGE WIND SPEED. NORMALLY EXTERNAL CIRCUITRY IS USED TO CONDITION THE A.C. SINE WAVE SIGNAL INTO SUITABLE FORMAT DEPENDING UPON THE SPECIFIC APPLICATION FOR THE INSTRUMENT.

RECORDERS AND INDICATING UNITS HAVE INTERFACE AND SIGNAL CONDITIONING CIRCUITS FOR CONVERTING THE SINE WAVE WIND SPEED SIGNAL INTO A LINEAR ANALOG VOLTAGE FOR RECORDING OR DISPLAY DIRECTLY IN METERS PER SECOND, MILES PER HOUR, OR KNOTS. THESE UNITS ARE FULLY CALIBRATED WITH THE SENSOR AND CONNECTING CABLE BEFORE SHIPMENT.

FOR APPLICATIONS IN WHICH THE WIND MONITOR WILL BE ADAPTED TO AN EXISTING RECORDER OR DATA LOGGER A SEPARATE SENSOR INTERFACE CARD IS AVAILABLE. THIS CARD CONVERTS THE SINE WAVE SIGNAL TO AN ANALOG VOLTAGE DIRECTLY PROPORTIONAL TO WIND SPEED. CARD OPERATION REQUIRES REGULATED SUPPLY VOLTAGE BETWEEN 8 VD.C. AND 15 VD.C. THIS SAME SUPPLY VOLTAGE CAN BE USED FOR POTENTIOMETER EXCITATION VOLTAGE. OUTPUT SIGNALS FROM THIS CARD ARE NORMALLY PRECALIBRATED TO 0-~~1.0~~ 5.0 VD.C. EQUAL TO 0-50 M/S (WITH 5 VD.C. SUPPLY). A SEPARATE SQUARE WAVE PULSE OUTPUT IS ALSO AVAILABLE.

CALIBRATION

WHEN THE WIND MONITOR IS UNPACKED IT SHOULD BE CHECKED CAREFULLY FOR ANY SIGNS OF SHIPPING DAMAGE. THE INSTRUMENT IS ALIGNED, BALANCED AND FULLY CALIBRATED BEFORE SHIPMENT, HOWEVER IT SHOULD BE CHECKED BOTH MECHANICALLY AND ELECTRICALLY BEFORE INSTALLATION.

THE VANE ASSEMBLY SHOULD EASILY ROTATE THE COMPLETE 360 DEGREES IN AZIMUTH WITHOUT ANY FRICTION POINTS. THE PROPELLER SHOULD ROTATE FREELY WHEN AIR FLOWS PAST THE INSTRUMENT. THIS IS MOST EASILY CHECKED BY BLOWING GENTLY ON THE PROPELLER AND VANE OR BY HOLDING THE INSTRUMENT BY HAND AND WALKING SLOWLY THROUGH CALM AIR IN A CLOSED ROOM.

VANE BALANCE CAN BE CHECKED BY HOLDING THE INSTRUMENT BY THE MOUNTING POST AND ROTATING SO THE VANE SURFACE IS HORIZONTAL. THE ASSEMBLY SHOULD HAVE NEAR NEUTRAL TORQUE, THAT IS NO PARTICULAR TENDENCY TO ROTATE NOSE DOWN OR TAIL DOWN. A SLIGHT IMBALANCE IS NOT SERIOUS.

CALIBRATION AND OPERATION ARE MOST EASILY BENCH CHECKED BEFORE ACTUAL FIELD INSTALLATION. THE WIND MONITOR SHOULD BE CONNECTED ELECTRICALLY WITH THE RECORDER OR INDICATING UNIT THROUGH THE MULTICONDUCTOR SENSOR CABLE. RECORDERS SHOULD BE CHECKED FOR PROPER MECHANICAL ZEROING BEFORE ANY VOLTAGE IS APPLIED TO THE SENSOR. IF ANY ADJUSTMENT IS REQUIRED THIS IS ACCOMPLISHED BY MEANS OF THE ZERO ADJUSTMENT LOCATED ON THE RECORDER. POWER CAN NOW BE SWITCHED ON. WITH REGULATED VOLTAGE APPLIED TO THE AZIMUTH POTENTIOMETER THE OUTPUT SIGNAL CAN BE CHECKED THROUGHOUT THE FULL 360 DEGREE VANE ROTATION. AS A MINIMUM THE VANE SHOULD BE ROTATED THROUGH 90 DEGREE STEPS AND THE INDICATOR OR RECORDER CHECKED FOR PROPER READING AT EACH CARDINAL POINT. HOLDING OR MOUNTING THE SENSOR SO THAT ITS CENTER OF ROTATION IS OVER THE CORNER OF A TABLE, A SQUARE SHEET OF PAPER, WILL ALLOW EASY VISUAL ALIGNMENT OF THE VANE. IF DESIRED, SMALLER INCREMENTS CHECKED BY DIVIDING INTO 45 DEGREE OR 30 DEGREE INCREMENTS IN A SIMILAR MANNER. THE OUTPUT SIGNAL SHOULD CORRESPOND TO ACTUAL VANE POSITION WITHIN PLUS OR MINUS 5 DEGREES, WHICH IS WITHIN THE [illegible] NORMAL OPERATIONAL ACCURACY OF THE INSTRUMENT. WITH CARE IN ALIGNMENT AND INSTALLATION IT IS POSSIBLE TO ACHIEVE AN ACCURACY OF ONE PER CENT OR BETTER [illegible] INSTRUMENT.

WIND SPEED CALIBRATION IS DETERMINED BY PROPELLER PITCH AND THE FIXED MAGNETIC AND ELECTRICAL CHARACTERISTICS OF THE TRANSDUCER CIRCUIT. CURVES ILLUSTRATING PROPELLER RPM VS WIND SPEED ARE INCLUDED WITH THESE INSTRUCTIONS. THE CALIBRATION VALUES GIVEN ON THESE CURVES ARE ACCURATE TO WITHIN PLUS OR MINUS [illegible] PER CENT. GREATER ACCURACY CAN BE ACHIEVED BY INDIVIDUAL WIND TUNNEL TESTING OF THE PROPELLER. THE OUTPUT [illegible]

OF THE WIND SPEED SIGNAL IS EXACTLY THREE FULL CYCLES PER PROPELLER REVOLUTION (WITH THE SIX POLE MAGNET). THE PEAK TO PEAK VOLTAGE OF THE A.C. SINE WAVE PRODUCED IN THE COIL IS PROPORTIONAL TO RPM. AT 60 RPM, WHICH IS APPROXIMATELY 0.3 M/S WIND SPEED (THRESHOLD) THE PEAK TO PEAK INDUCED VOLTAGE IS ABOUT 50 MILLIVOLTS. THIS VOLTAGE CHANGE IS USED AS A TRIGGER IN EXTERNAL SIGNAL CONDITIONING CIRCUITS TO PRODUCE A SQUARE WAVE PULSE FREQUENCY OUTPUT AS WELL AS AN ANALOG VOLTAGE PROPORTIONAL TO WIND SPEED. THE FREQUENCY TO VOLTAGE CONVERSION IS NORMALLY ACCURATE TO WITHIN ONE PER CENT.

EXPOSURE AND ORIENTATION

EXPOSURE OF THE WIND MONITOR TO GET REPRESENTATIVE WIND DIRECTION DATA IS VERY IMPORTANT. EDDIES IN THE LEE OF TREES, BUILDINGS, OR OTHER STRUCTURES CAN GREATLY REDUCE THE VALUE OF WIND SPEED AND DIRECTION OBSERVATIONS. IN ORDER TO GET MEANINGFUL WIND MEASUREMENTS, IT WILL BE NECESSARY TO LOCATE THE INSTRUMENT WELL ABOVE OR TO WINDWARD OF SUCH OBSTRUCTIONS.

> AS A RULE OF THUMB, THE NORMAL FLOW OF AIR PAST A BUILDING WILL DISTURB THE AIR FLOW ABOUT TWICE THE HEIGHT OF THE BUILDING TO WINDWARD; SIX TIMES THE HEIGHT OF THE BUILDING TO LEEWARD; AND UP TO TWICE THE HEIGHT OF THE BUILDING ABOVE THE GROUND.

INSTALLATION AND ORIENTATION OF THE INSTRUMENT IS MOST EASILY ACCOMPLISHED WITH TWO PEOPLE; ONE AT THE SENSOR TO ADJUST ORIENTATION AND ANOTHER AT THE INDICATOR OR RECORDER LOCATION TO SIGNAL WHEN THE RECORDER READING CORRESPONDS TO THE ACTUAL VANE POSITION. THE ORIENTATION RING AND MOUNTING POST OF THE INSTRUMENT ARE INSTALLED ON A VERTICAL 1 INCH PIPE (STANDARD IRON PIPE SIZE) AND THE SENSOR CABLE ATTACHED. NOTE THAT THE SENSOR CABLE CONNECTIONS ARE MADE IN THE JUNCTION BOX AT THE BASE OF THE INSTRUMENT. THE CABLE MAY BE ROUTED DIRECTLY THROUGH THE BOTTOM OF THE JUNCTION BOX, OR FOR PERMANENT INSTALLATION, THE CABLE MAY BE ROUTED THROUGH THE 1 INCH MOUNTING PIPE AND INTO THE JUNCTION BOX THROUGH THE SIDE OF THE MOUNTING POST.

THE VANE IS POINTED TOWARD A DISTANT REFERENCE POINT, OF KNOWN AZIMUTH, BY SIGHTING ALONG THE CENTERLINE OF THE INSTRUMENT. WHILE THE VANE IS HELD IN A FIXED POSITION, THE MOUNTING POST OF THE INSTRUMENT IS SLOWLY TURNED ON THE MOUNTING PIPE UNTIL THE INDICATOR, RECORDER, OR DATA LOGGER GIVES THE PROPER READING. IT IS USUALLY EASIEST TO SIGHT FROM THE PROPELLER END TOWARD THE FIN, WITH THE OUTPUT SIGNAL READING 180 DEGREES FROM THE REFERENCE POINT. ONCE THE INSTRUMENT IS PROPERLY ORIENTED THE TWO SET SCREWS IN THE MOUNTING POST ARE TIGHTENED. THE ORIENTATION RING IS RAISED AND THE INDEXING PIN IS ENGAGED IN THE SLOT IN THE INSTRUMENT MOUNTING POST. THE TWO SET SCREWS IN THE RING ARE THEN TIGHTENED TO LOCK IT IN PLACE ON THE MOUNTING PIPE. THE INDEX SLOT ON THE MOUNTING POST HAS BEEN ALIGNED WITH THE AZIMUTH POTENTIOMETER BEFORE SHIPMENT SO THAT IT IS ORIENTED DUE SOUTH.

BAND CLAMPS ARE USED ON MOD. 05103 TO SECURE THE INSTRUMENT AND ORIENTATION RING TO THE MOUNTING POST

MAINTENANCE

THE WIND MONITOR IS DESIGNED FOR LOW MAINTENANCE. CONSTRUCTION IS ENTIRELY OF NON-CORROSIVE MATERIALS AND ALL COMPONENTS ARE CONSERVATIVELY RATED. THE ONLY COMPONENTS THAT ARE LIKELY TO REQUIRE REPLACEMENT ARE THE PRECISION BALL BEARINGS AND THE AZIMUTH POTENTIOMETER. REPLACEMENT OF THESE COMPONENTS SHOULD ONLY BE ATTEMPTED BY A QUALIFIED INSTRUMENT TECHNICIAN. IF SERVICE FACILITIES ARE NOT AVAILABLE THE INSTRUMENT SHOULD BE RETURNED TO THE COMPANY.

THE PRECISION POTENTIOMETER HAS A LIFE EXPECTANCY OF OVER TEN MILLION REVOLUTIONS, AND SHOULD LAST 3-5 YEARS IN NORMAL USE. THE CONDUCTIVE PLASTIC POTENTIOMETER ELEMENT WILL USUALLY BEGIN TO INCREASE IN RESISTANCE AS IT BECOMES WORN. WHEN TOTAL RESISTANCE INCREASES 10% OR MORE THE POTENTIOMETER SHOULD BE REPLACED.

REFER TO THE EXPLODED ASSEMBLY DRAWING TO BECOME FAMILIAR WITH PART NAMES AND LOCATIONS. TO GAIN ACCESS TO THE POTENTIOMETER SIMPLY REMOVE THE FOUR 8-32 PAN HEAD SCREWS IN THE SIDES OF THE MAIN HOUSING.* THE ENTIRE BODY OF THE INSTRUMENT CAN THEN BE REMOVED FROM THE MOUNTING AND TRANSDUCER ASSEMBLY BY SLIDING IT UPWARD AND OFF OF THE VERTICAL SHAFT BEARING MOUNTING. NEXT LOOSEN THE 3-48 SET SCREW IN THE POTENTIOMETER COUPLING AND REMOVE THE COUPLING FROM THE POTENTIOMETER SHAFT EXTENSION. THE POTENTIOMETER MOUNTING AND COIL ASSEMBLY CAN THEN BE UNTHREADED FROM THE POTENTIOMETER HOUSING. EXERCISE CARE IN HANDLING TO AVOID DAMAGING

* REFER TO CHANGES INCORPORATED ON MODEL 05103

THE COIL WIRE OR CONNECTIONS. WHEN THE POTENTIOMETER MOUNTING AND COIL ASSEMBLY IS SEPARATED FROM THE POTENTIOMETER HOUSING THE POTENTIOMETER CAN BE PUSHED OUT OF ITS MOUNTING BY APPLYING FIRM BUT GENTLE PRESSURE ON THE POTENTIOMETER SHAFT EXTENSION. THE POTENTIOMETER ASSEMBLY IS A FRICTION FIT IN THE MOUNTING WITH SMALL PROJECTIONS WHICH FIT INTO THE POTENTIOMETER SERVO MOUNTING RING. THE POTENTIOMETER WILL "SNAP" INTO AND OUT OF POSITION. USE A LOW WATTAGE SOLDER IRON WHEN CHANGING LEAD WIRE CONNECTIONS AND AVOID PROLONGED CONTACT WITH THE POTENTIOMETER TERMINALS. THE POTENTIOMETER TERMINALS ARE EASILY DAMAGED FROM EXCESSIVE HEAT.

AFTER REASSEMBLY OF THE POTENTIOMETER MOUNTING AND COIL ASSEMBLY WITH THE POTENTIOMETER HOUSING APPLY A SMALL AMOUNT OF SILICONE SEALANT AT THE POINT WHERE THE LEAD WIRES EXIT THE HOUSING. WHEN REASSEMBLING THE POTENTIOMETER COUPLING TO THE POTENTIOMETER SHAFT EXTENSION CAREFULLY REALIGN THE POTENTIOMETER SHAFT EXTENSION TO GIVE AN OUTPUT SIGNAL READING OF 180 DEGREES WHEN THE INDEXING FINGER ON THE COUPLING IS IN LINE WITH THE SOUTH NOTCH AT THE BOTTOM OF THE MOUNTING POST. FINAL ADJUSTMENTS CAN BE MADE AFTER ASSEMBLY THROUGH THE FRONT OPENING OF THE MAIN HOUSING WHICH IS ACCESSABLE BY REMOVING THE NOSE CONE ASSEMBLY.

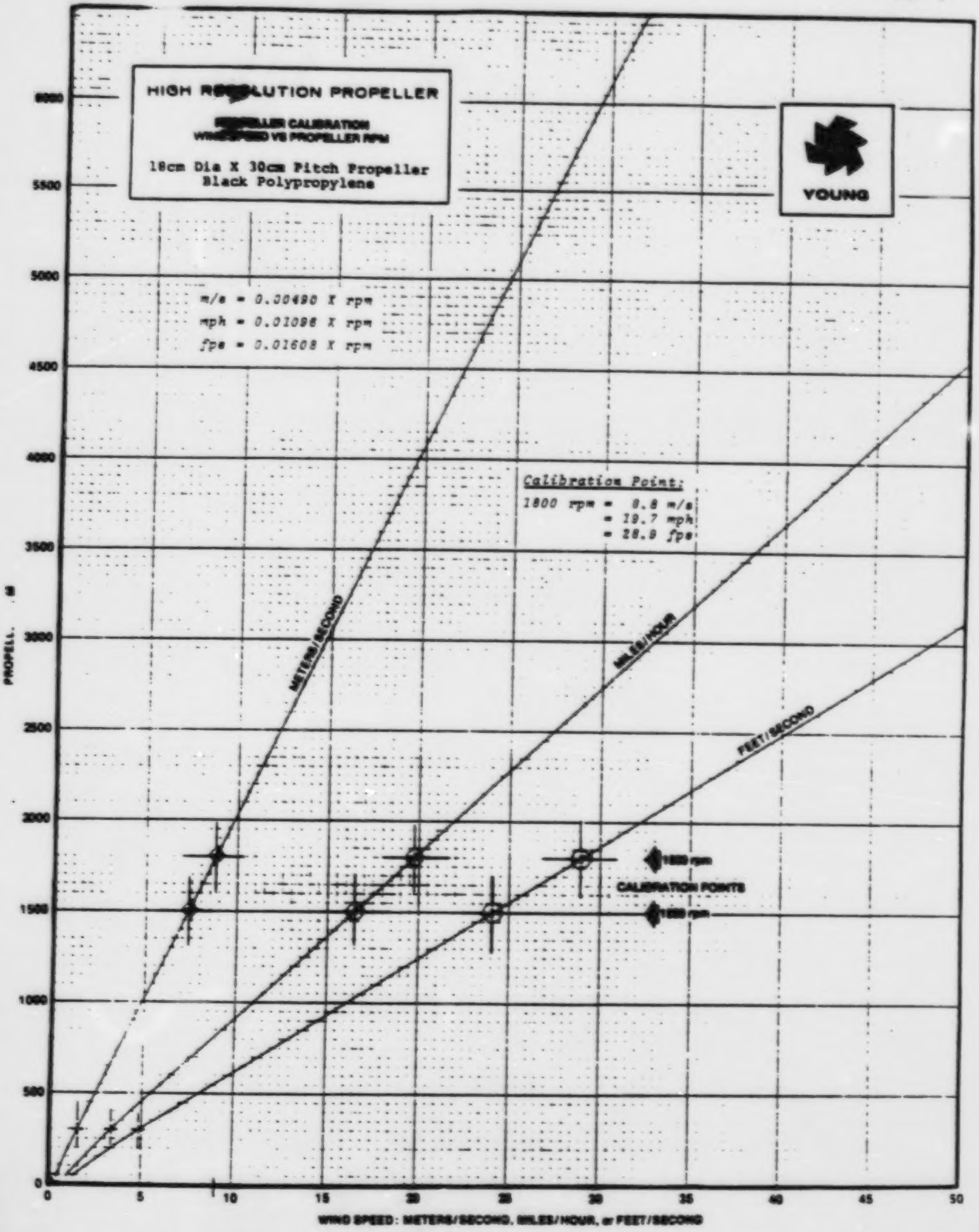
IF ANEMOMETER BEARINGS BECOME NOISY OR IF WIND SPEED THRESHOLD INCREASES ABOVE AN ACCEPTABLE LEVEL THE BEARINGS SHOULD BE REPLACED. ANEMOMETER FLANGE BEARING REPLACEMENT IS EASILY ACCOMPLISHED AFTER REMOVAL OF THE PROPELLER AND REMOVAL OF THE NOSE CONE ASSEMBLY FROM THE MAIN HOUSING. NOTE THAT THE PROPELLER HUB IS MOLDED IN PLACE ON THE STAINLESS STEEL PROPELLER SHAFT SO THAT THIS IS A SINGLE PERMANENT ASSEMBLY. TO REPLACE BEARINGS LOOSEN THE SET SCREW IN THE MAGNET & SHAFT COLLAR AND REMOVE FROM THE SHAFT. THE PROPELLER SHAFT & HUB ASSEMBLY CAN THEN BE SLID FORWARD OUT OF BOTH FRONT AND REAR FLANGE BEARINGS. NEXT REMOVE THE FRONT BEARING CAP WHICH COVERS THE FRONT BEARING. BOTH BEARINGS CAN THEN BE REMOVED WITH THE AID OF A SMALL POCKET KNIFE INSERTED UNDER THE BEARING FLANGE. AFTER NEW BEARINGS ARE INSTALLED REASSEMBLE THE COMPONENTS BEING CAREFUL NOT TO APPLY EXCESSIVE PRESSURE ON THE NEW BEARINGS WHEN REINSERTING THE PROPELLER SHAFT. WHEN THE MAGNET AND SHAFT COLLAR IS REINSTALLED ALLOW A CLEARANCE OF APPROXIMATELY ~~0.1~~ 0.5 MM (~~0.00[illegible]"~~ 0.020") TO AVOID ANY BINDING OF THE BEARINGS DUE TO DIFFERENTIAL EXPANSION OF COMPONENTS WITH TEMPERATURE CHANGES.

VERTICAL SHAFT BEARINGS ARE MUCH LARGER THAN THE ANEMOMETER BEARINGS AND ARE NOT AS CRITICAL FOR PROPER INSTRUMENT PERFORMANCE. REPLACEMENT IS ALSO SOMEWHAT MORE DIFFICULT. THESE BEARINGS WILL NOT NORMALLY REQUIRE REPLACEMENT AT THE SAME INTERVAL AS ANEMOMETER BEARINGS. IF BEARING CONDITION IS NOT APPARENT IT CAN BE CHECKED BY SIMPLY HOLDING THE INSTRUMENT ON ITS SIDE WITH THE VANE HORIZONTAL. PLACE A SMALL WEIGHT OF 2-3 GMS NEAR THE AFT EDGE OF THE FIN. IF THE WEIGHT CAUSES THE ASSEMBLY TO ROTATE DOWNWARD BEARING CONDITION IS STILL GOOD. THIS CHECK CAN BE REPEATED AT DIFFERENT POSITIONS OF THE BEARING TO CHECK FULL ROTATION. A U.S. PENNY WEIGHS ABOUT 3 GMS AND IS A CONVENIENT WEIGHT FOR THIS CHECK.

VERTICAL SHAFT BEARING REPLACEMENT REQUIRES REMOVAL OF THE MAIN HOUSING FROM THE TRANSDUCER ASSEMBLY AS PREVIOUSLY DESCRIBED. IT IS ALSO NECESSARY TO UNSOLDER THE FIVE TRANSDUCER LEAD WIRES AT THE TERMINAL STRIP IN THE JUNCTION BOX. LOOSEN THE TWO 8-32 SET SCREWS IN THE UPPER PART OF THE MOUNTING POST WHICH SECURE THE VERTICAL SHAFT TUBE ASSEMBLY. SLIDE THE VERTICAL SHAFT BEARING MOUNTING AND VERTICAL SHAFT TUBE ASSEMBLY UPWARD OUT OF THE MOUNTING POST. NEXT CAREFULLY PULL THE TRANSDUCER LEAD WIRES OUT OF THE JUNCTION BOX. THE VERTICAL SHAFT BEARING MOUNTING WITH BOTH UPPER AND LOWER VERTICAL SHAFT BEARINGS CAN THEN BE REMOVED DOWNWARD FROM THE VERTICAL SHAFT TUBE ASSY. AFTER NEW BEARINGS ARE INSTALLED REASSEMBLE COMPONENTS AND FEED THE TRANSDUCER LEAD WIRES BACK THROUGH THE SMALL HOLE IN THE MOUNTING POST INTO THE JUNCTION BOX FOR RESOLDERING. WHEN SECURING THE 8-32 SET SCREWS IN THE VERTICAL SHAFT TUBE ASSEMBLY ALLOW A BEARING END CLEARANCE OF APPROXIMATELY 0.1 MM (0.004") TO PREVENT BINDING OF BEARINGS DUE TO DIFFERENTIAL EXPANSION.

BEARINGS AND THE POTENTIOMETER ARE THE ONLY PARTS LIKELY TO REQUIRE REPLACEMENT EXCEPT IN THE EVENT OF PHYSICAL DAMAGE TO THE INSTRUMENT. GIVEN REASONABLE CARE THIS WIND SENSOR SHOULD PROVIDE MANY YEARS OF TROUBLE FREE SERVICE.

JAN 79


HIGH RESOLUTION PROPELLER
PROPELLER CALIBRATION
WINDSPEED VS PROPELLER RPM
18cm Dia X 30cm Pitch Propeller
Black Polypropylene
YOUNG
m/s = 0.00490 X rpm
mph = 0.01096 X rpm
fps = 0.01608 X rpm
Calibration Point:
1800 rpm = 8.8 m/s
= 19.7 mph
= 28.9 fps
METERS/SECOND
MILES/HOUR
FEET/SECOND
1800 rpm
CALIBRATION POINTS
1500 rpm
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
PROPELL.
0
5
10
15
20
25
30
35
40
45
50
WIND SPEED: METERS/SECOND, MILES/HOUR, or FEET/SECOND

JAN 79

YOUNG

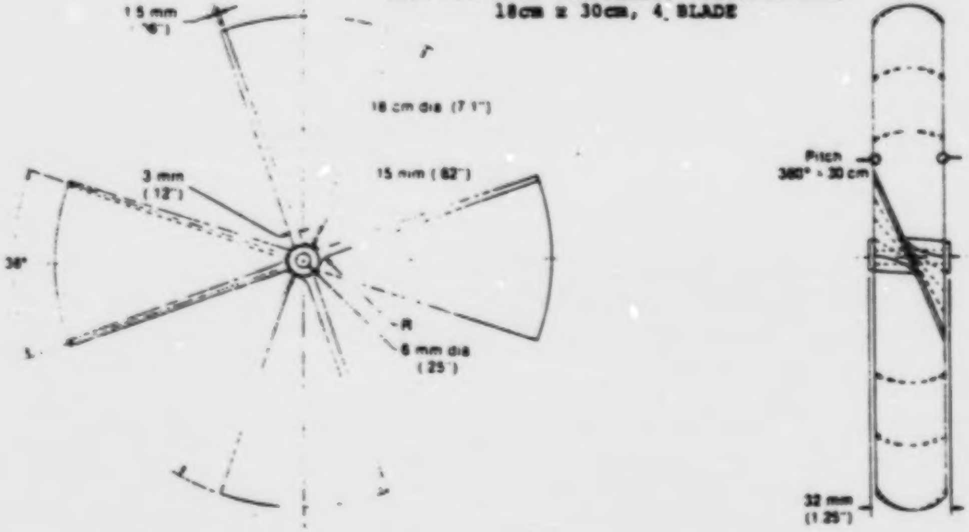
HIGH RESOLUTION PROPELLER

These injection molded thermoplastic propellers are intended for direct substitution for the polystyrene 4 blade propellers for applications requiring greater physical strength as well as an extended working range. They may be used in place of the sensitive polystyrene 4 blade propellers without significant change in calibration. Cosine response is also similar.

The helicoid shape 18cm diameter x 30cm pitch propeller is a one piece molding of polypropylene plastic with a specific gravity of 0.9, resulting in a total weight of 31gm (1.1 oz). Distance constant is 3.3m (10.5 ft). (Distance constant is the wind passage required for 63% recovery from a step change in wind speed.) Polypropylene is a very flexible and durable material making this propeller highly resistant to failure from high winds as well as icing and hail damage.

Working range is 0-50m/s (112mph). Threshold is 0.2-0.4m/s (0.5-0.9mph). Threshold is measured with the propeller mounted on a standard sensor with precision instrument grade ball bearings and driving a miniature tachometer generator.

CAT. NO: 8234 PROPELLER, POLYPROPYLENE
18cm x 30cm, 4 BLADE



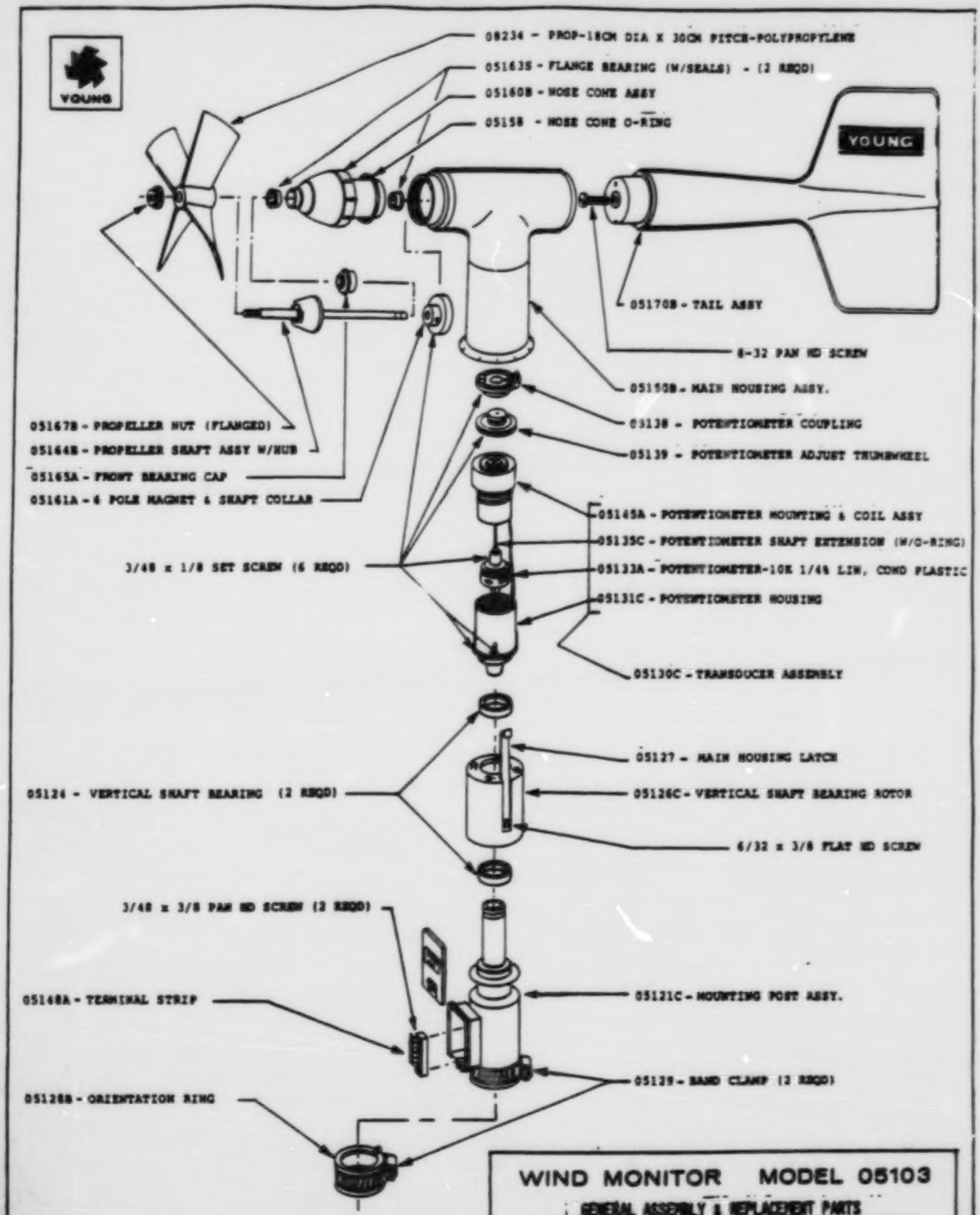
SPECIFICATIONS:

RANGE - AXIAL FLOW:	50 m/s (112 mph)
RANGE - ALL ANGLE:	50 m/s (112 mph)
THRESHOLD:	0.2 - 0.4 m/s (0.5 - 0.9 mph)
DISTANCE CONSTANT:	3.3m (10.5 ft.)
EFFECTIVE PITCH:	29.4cm (0.96 ft.)
WORKING TEMPERATURE:	120°C (248°F)
MATERIAL:	POLYPROPYLENE (SPECIFIC GRAVITY 0.9)

CALIBRATION POINTS:

HORIZONTAL -	3600 rpm	17.6 m/s	(39.5 mph)
	3000 rpm	14.7 m/s	(32.9 mph)
	1800 rpm	8.8 m/s	(19.7 mph)
	1500 rpm	7.4 m/s	(16.4 mph)
	300 rpm	1.5 m/s	(3.4 mph)
	250 rpm	1.2 m/s	(2.7 mph)
VERTICAL -	1800 rpm	11.0 m/s	(24.6 mph)
	1500 rpm	9.3 m/s	(20.8 mph)
	300 rpm	1.8 m/s	(4.0 mph)
	250 rpm	1.5 m/s	(3.4 mph)

R.M. YOUNG COMPANY
2801 Aero-Park Drive, Traverse City, MI 49684, U.S.A.
Phone (616) 946-3980 TWX 810-291-3366


YOUNG
08234 - PROP-18CM DIA X 30CM PITCH-POLYPROPYLENE
05163S - FLANGE BEARING (W/SEALS) - (2 REQD)
05160B - NOSE CONE ASSY
05158 - NOSE CONE O-RING
YOUNG
05170B - TAIL ASSY
8-32 PAN HD SCREW
05150B - MAIN HOUSING ASSY.
05138 - POTENTIOMETER COUPLING
05139 - POTENTIOMETER ADJUST THUMBWHEEL
05167B - PROPELLER NUT (FLANGED)
05164B - PROPELLER SHAFT ASSY W/HUB
05165A - FRONT BEARING CAP
05161A - 4 POLE MAGNET & SHAFT COLLAR
05145A - POTENTIOMETER MOUNTING & COIL ASSY
05135C - POTENTIOMETER SHAFT EXTENSION (W/O-RING)
3/48 x 1/8 SET SCREW (6 REQD)
05133A - POTENTIOMETER-10K 1/4% LIN, COND PLASTIC
05131C - POTENTIOMETER HOUSING
05130C - TRANSDUCER ASSEMBLY
05127 - MAIN HOUSING LATCH
05124 - VERTICAL SHAFT BEARING (2 REQD)
05126C - VERTICAL SHAFT BEARING ROTOR
6/32 x 3/8 FLAT HD SCREW
3/48 x 3/8 PAN HD SCREW (2 REQD)
05148A - TERMINAL STRIP
05121C - MOUNTING POST ASSY.
05129 - BAND CLAMP (2 REQD)
05128B - ORIENTATION RING

WIND MONITOR MODEL 05103

GENERAL ASSEMBLY & REPLACEMENT PARTS

R.M. YOUNG COMPANY
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Phone (616) 946-3980 TWX 810-291-3366

AUG. 84

YOUNG

WIND MONITOR MODEL 05103

R.M.YOUNG COMPANY - REPLACEMENT PARTS

MODEL 05103 WIND MONITOR 10-84

PART No.	PART NAME	
05121C	MOUNTING POST ASSY	
05124	VERTICAL SHAFT BEARING	2 REQD
05126C	VERTICAL SHAFT BEARING ROTOR	
05127	MAIN HOUSING LATCH	
05128B	ORIENTATION RING	
05129	BAND CLAMP	2 REQD
05130C	TRANSDUCER ASSEMBLY	
05131C	POTENTIOMETER HOUSING	
05133A	POTENTIOMETER-10K 1/4% LIN. COND PLASTIC	
05135C	POTENTIOMETER SHAFT EXTENSION (W/O-RING)	
05138	POTENTIOMETER COUPLING	
05139	POTENTIOMETER ADJUST THUMBWHEEL	
05145A	POTENTIOMETER MOUNTING & COIL ASSY	
05148A	TERMINAL STRIP	
05150B	MAIN HOUSING ASSY	
05158	NOSE CONE O-RING	
05160B	NOSE CONE ASSY	
05161A	6 POLE MAGNET & SHAFT COLLAR	
05163S	FLANGE BEARING (W/SEALS)	2 REQD
05164B	PROPELLER SHAFT ASSY W/HUB	
05165A	FRONT BEARING CAP	
05167B	PROPELLER NUT (FLANGED)	
05170B	TAIL ASSY	
08234	PROP-18CM DIA x 30CM PITCH-POLYPROPYLENE	

R.M. YOUNG COMPANY
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Phone (616) 946-3980 TWX 810-291-3366

CABLE AND WIRING DIAGRAM
WIND MONITOR 05103

WIND SPEED:

ELECTRO-MAGNETIC TRANSDUCER GENERATES A.C. SIGNAL. FREQUENCY IS DIRECTLY PROPORTIONAL TO WIND SPEED. EACH FULL CYCLE OF OUTPUT REPRESENTS 10 CM OF WIND PASSAGE.

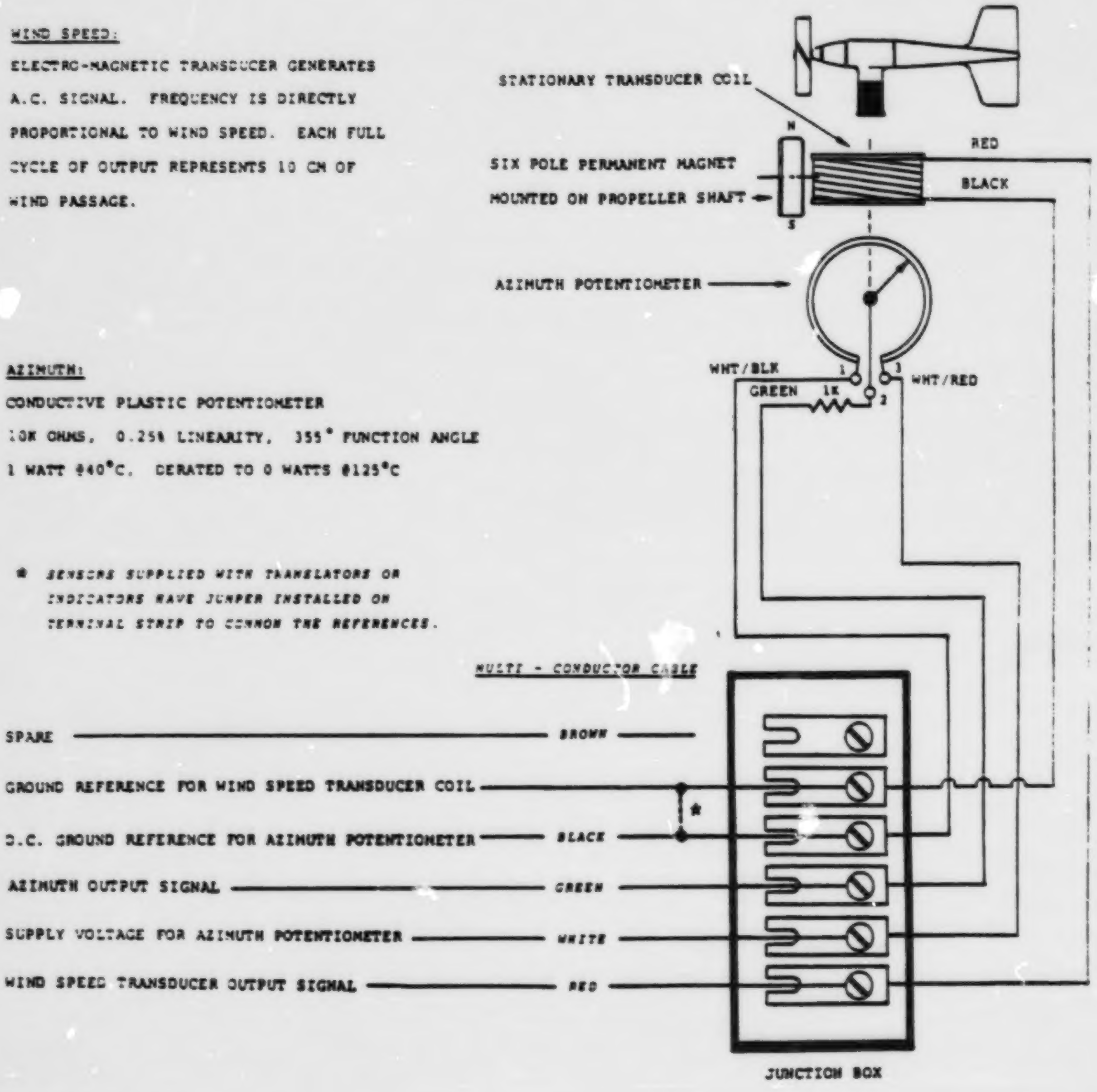
AZIMUTH:

CONDUCTIVE PLASTIC POTENTIOMETER

10K OHMS, 0.25% LINEARITY, 355° FUNCTION ANGLE

1 WATT @40°C, DERATED TO 0 WATTS @125°C

* *SENSORS SUPPLIED WITH TRANSLATORS OR INDICATORS HAVE JUMPER INSTALLED ON TERMINAL STRIP TO COMMON THE REFERENCES.*


STATIONARY TRANSDUCER COIL
SIX POLE PERMANENT MAGNET
MOUNTED ON PROPELLER SHAFT
N
S
RED
BLACK
AZIMUTH POTENTIOMETER
WHT/BLK
1
3
WHT/RED
GREEN
1K
2
MULTI - CONDUCTOR CABLE
SPARE
BROWN
GROUND REFERENCE FOR WIND SPEED TRANSDUCER COIL
*
D.C. GROUND REFERENCE FOR AZIMUTH POTENTIOMETER
BLACK
AZIMUTH OUTPUT SIGNAL
GREEN
SUPPLY VOLTAGE FOR AZIMUTH POTENTIOMETER
WHITE
WIND SPEED TRANSDUCER OUTPUT SIGNAL
RED
JUNCTION BOX

FOR TEMPORARY INSTALLATIONS, THE MULTI-CONDUCTOR CONNECTING CABLE MAY BE ROUTED DIRECTLY THROUGH THE BOTTOM OF THE JUNCTION BOX.

FOR PERMANENT INSTALLATIONS, THE CONNECTING CABLE GOING TO THE JUNCTION BOX MAY BE ROUTED THROUGH THE INSIDE OF THE MOUNTING PIPE AND MOUNTING ADAPTER.

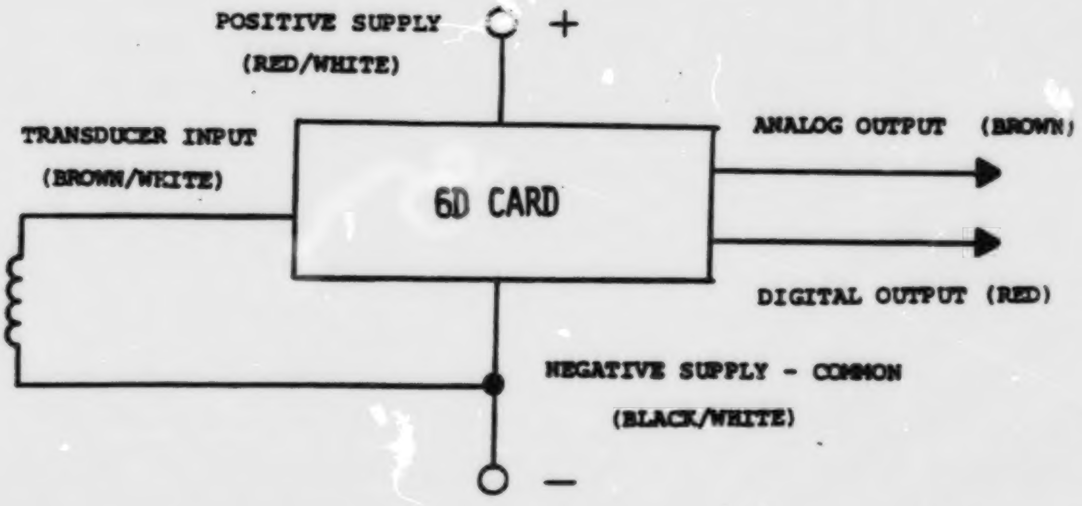
CATALOG NUMBER 05602 6D CARD

LOW TEMPERATURE/LOW CURRENT FREQUENCY-TO-VOLTAGE CONVERTER

This circuit converts the a.c. signal from the WIND MONITOR to an analog voltage that is directly proportional to wind speed. This low power circuit maintains good accuracy at low yemperatures and over a wide range of supply voltages.

SPECIFICATIONS

Supply Voltage	8 volts d.c. to 15 volts d.c.
Supply Current	1 m.A. with a 12 volt supply
Operating Temperature	-40° C to +85° C
Output Voltage	5 volts d.c. max (adjustable)
Input Sensitivity	40 m.V. p-p
Overall Accuracy	±1% over temperature and supply voltage range


POSITIVE SUPPLY (RED/WHITE)
+
TRANSDUCER INPUT (BROWN/WHITE)
6D CARD
ANALOG OUTPUT (BROWN)
DIGITAL OUTPUT (RED)
NEGATIVE SUPPLY - COMMON (BLACK/WHITE)
−

NOTES:

- The input stage of this circuit is designed to work with the WIND MONITOR. An alternate input may be provided for signals from other transducers.
- The load on the analog output must be 10K ohms or greater to maintain low current drain.
- The digital output signal is normally high and pulses low at the same frequency as the signal from the wind speed transducer.
- DO NOT short the analog output or digital output to either supply line. Permanent damage to the circuit could result.

CALIBRATION SPECIFICATION

FULL SCALE VOLTAGE OUTPUT 1.0 VDC

FULL SCALE WIND SPEED 50 M/S

WIND STATION # _

FEB 84

[illegible]

CALIBRATION UNIT

MODEL: 27230 (1800 RPM) 27231 (300 RPM)
27232 (3600 RPM)

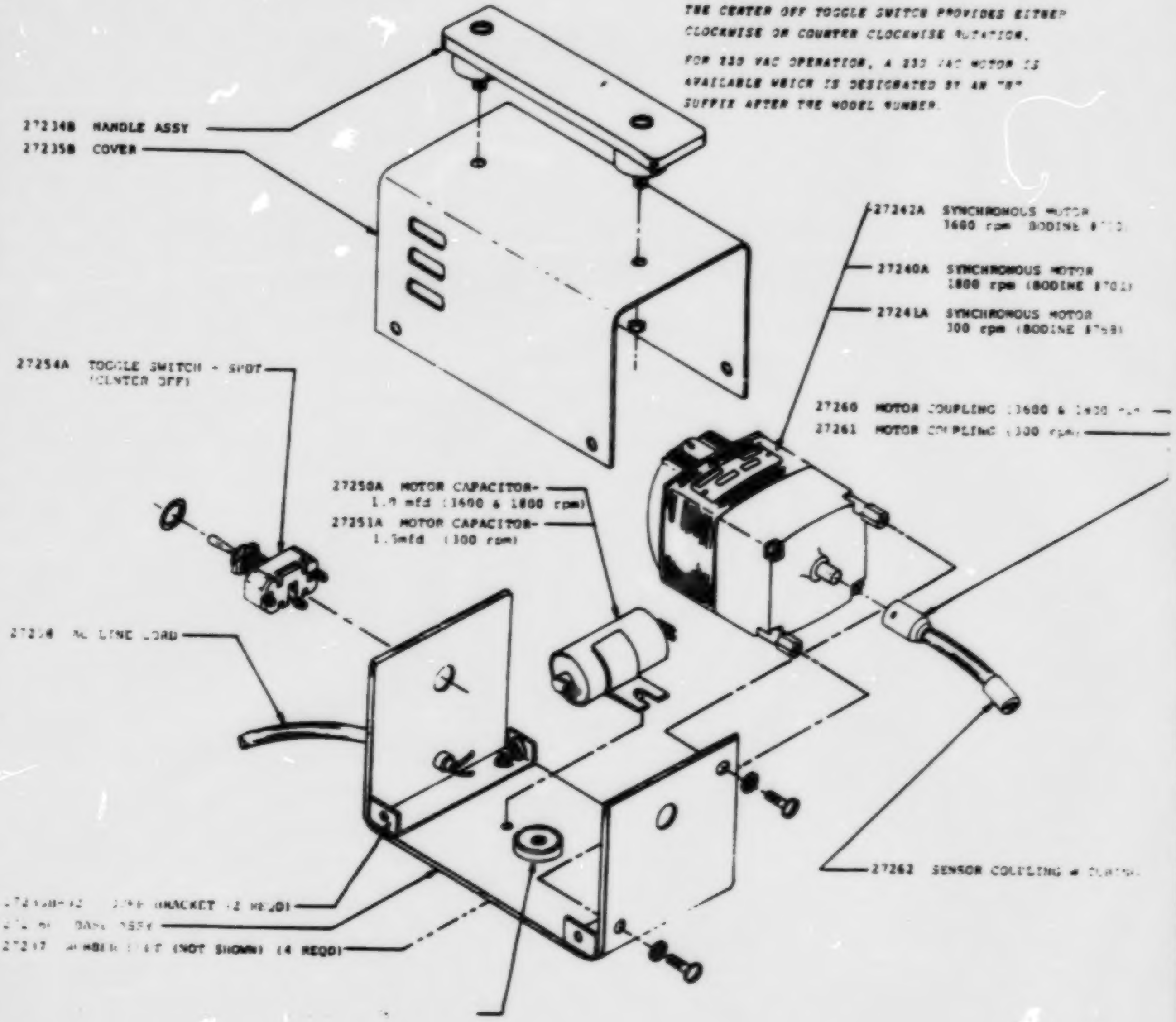
GENERAL ASSEMBLY & REPLACEMENT PARTS

R. M. YOUNG COMPANY
2801 AERO PARK DRIVE TRAVERSE CITY MICHIGAN 49684

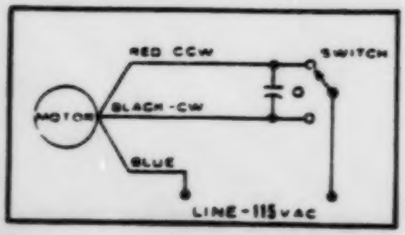
THE SYNCHRONOUS MOTOR CALIBRATING UNIT IS A HAND HELD [illegible] USED FOR CALIBRATION OF WIND SPEED SIGNALS. THE FLEXIBLE COUPLING ENGAGES THE TWO FLATS ON THE SHAFT OF CUP TYPE [illegible] PROPELLER TYPE ANEMOMETERS (WITH CUP WHEEL OR PROPELLER REMOVED). THE UNIT PROVIDES A KNOWN ROTATIONAL SPEED SO THAT THE OUTPUT SIGNAL CAN BE ADJUSTED TO PROVIDE THE DESIRED METER OR RECORDER READING AS INDICATED ON THE CALIBRATION CURVES SUPPLIED WITH EACH WIND INSTRUMENT.

THE CENTER OFF TOGGLE SWITCH PROVIDES EITHER CLOCKWISE OR COUNTER CLOCKWISE ROTATION.

FOR 230 VAC OPERATION, A 230 VAC MOTOR IS AVAILABLE WHICH IS DESIGNATED BY AN "[illegible]" SUFFIX AFTER THE MODEL NUMBER.


27234B HANDLE ASSY
27235B COVER
27242A SYNCHRONOUS MOTOR 3600 rpm (BODINE #[illegible])
27240A SYNCHRONOUS MOTOR 1800 rpm (BODINE #701)
27241A SYNCHRONOUS MOTOR 300 rpm (BODINE #759)
27254A TOGGLE SWITCH - SPDT (CENTER OFF)
27260 MOTOR COUPLING (3600 & 1800 rpm)
27261 MOTOR COUPLING (300 rpm)
27250A MOTOR CAPACITOR- 1.9 mfd (3600 & 1800 rpm)
27251A MOTOR CAPACITOR- 1.5mfd (300 rpm)
AC LINE CORD
27262 SENSOR COUPLING w [illegible]
BRACKET (2 REQD)
BASE ASSY
27217 RUBBER FEET (NOT SHOWN) (4 REQD)

CONNECTION DIAGRAM



SYNCHRONOUS MOTORS:

[illegible]

POLYCORDER

570P Module

Download Module Programmer

OMNIDATA INTERNATIONAL, INC.
P.O. Box 3489
Logan, Utah 84321
(801) 753-7760

THE DOWNLOAD MODULE PROGRAMMER

The Download Module Programmer allows you to create Download Modules which:

- --quickly reconfigure your Polycorder
- --easily load the same program into several Polycorders
- --create permanent reference files

at low cost and without the incovenience of requesting these services from the factory.

ABOUT THE EPROM

EPROM is an acronym for Erasable Programmable Read-Only Memory. You can program an EPROM directly using the programmer. The colloquial expression for this is "burning an EPROM."

An EPROM requires no power to maintain information, thus making the data virtually permanent. The information is erasable, but only by an hour's exposure under a special high intensity ultraviolet light. Direct exposure to the sun will affect the EPROM only after two years of continuous exposure.

USE OF THE EPROM

Using the programmer, you can burn:

1) Files and programs
2) A memory image

within the following parameters:

1) You can burn all the files you have in your Polycorder (or just the files you want). However, you must burn all at the one time.

2) You can burn the entire memory image in the Polycorder, including all the autolog set-up, the protocol, the files, etc. for the purpose of setting up other Polycorders. (Note: You cannot, however, set the Polycorder clock with an EPROM.)

BURNING PROCEDURE

1) Set the baud rate on the Polycorder at 1200.

2) Use the supplied cable to connect the RS-232 port on the Polycorder and the same port on the burner.

3) Now enter Mode 7-3. *On the display you should see the number 2732>.①This means you are properly connected.

4) Now ESC and enter Mode 8.

5) The Polycorder will then ask you what you want to do. You have three options:

LOAD -- is the downloading option to allow you to transfer the contents of the download module into the Polycorder

Macine

* Key in several blanks. On [illegible]

① You will see only the last few characters.

PGM (burn)--this is the one you want
but again you have two PGM options:
PGM-F (burning files, either programs or data)
PGM-M (burning a memory image)
Select one of these two options.

6) The Polycorder will then ask READY?, meaning "Have you plugged the EPROM into the socket on the programmer?" and "Is everything connected?" If everything is ready, press ENTER. The red light on the programmer should light up.

7) The Polycorder will then show a number on the display and start counting down. When the counting down stops, the burning process is completed.

Note: Sometimes you will need more than one EPROM to burn a memory image. When the first EPROM is full, the display will show READY?. Remove the first EPROM and plug in another. Press ENTER. Be sure to mark the EPROMs in order. They need to be downloaded in the same order as programmed.

OTHER PROGRAMMING HINTS

When you wish to burn a file, scroll through the file directory in the Polycorder to find the file you want to burn. Press ENTER. When the burning of the file is complete, the Polycorder will ask for the name of the next file to be burned. Repeat the process until you have burned all the files you need. Then pressed ESC. Remember, once you press ESC, you cannot go back and add more files to the EPROM.

In the Polycorder directory, you can find the number of bytes per file. By adding these figures together for the files you want to burn, you can estimate if you can put everything on one EPROM. An EPROM will hold approximately 4000 bytes of information.

The Omnidata programmer uses only 2732 EPROMs.

After you set the baud rate for the Polycorder, the programmer will automatically set itself for the same rate.

Static kills EPROMs. Don't zap 'em. The C-MOS and MOS circuitry used in the EPROMs is very voltage-sensitive. Most of us naturally carry hundreds of volts on our persons--and EPROMs can be zapped with just a few hundred volts. In addition, even a simple movement such as walking across a carpet can generate 2000-3000 volts. One of the best steps you can take to prevent zapping your EPROMS is transporting them in a static safe container.

Putting them in anti-static black foam is a good idea. NEVER PUT EPROMS IN A PLASTIC BAG FOR SHIPPING OR STORING. AND BE CAREFUL WORKING WITH EPROMS AROUND PLASTICS AND NYLON.

If you run into trouble, the following error codes may be displayed.

*WP ERR nnnn	Cell won't PROGRAM. EPROM is no good or the wrong device type was selected or the device was mis-socketed, in which case, the device may or may not be good now.
*NE ERR nnnn	Can't program the cell because it NEEDS ERASING.
*DT ERR nnnn	DATA error. Not valid hex data.
*CS ERR nnnn	CHECK SUM error detected in hex record.
*SN ERR nnnn	SYNTAX error.
*ST ERR nnnn	STACK error. Overflow. Reduce baud rate.

Error codes include the address (nnnn) at which the error occurred.

PROGRAMMER SPECIFICATIONS

DIMENSIONS............................	5.25" x 6.75" x 2.75"
POWER REQUIREMENTS....................	120VAC, 60HZ, 10VA 240VAC,50HZ optional)
INTERFACE CONNECTOR................	DB25p configured as data terminal equipment
DATA WORD SIZE......................	1 start bit, 8 data bits, 1 stop bit and no parity
BAUD RATE.............................	Auto select 300,600, 1200
WEIGHT................................	3 pounds
OPERATING ENVIRONMENT.................	45-95 DEG. F (7-35 DEG. C.) 5% to 95% non-condensing relative humidity

DigiCOURSE®
A SUBSIDIARY OF THE LAITRAM CORPORATION
P O Box 50699, New Orleans, La. 70150 U S A • Phone (504) 733-6061

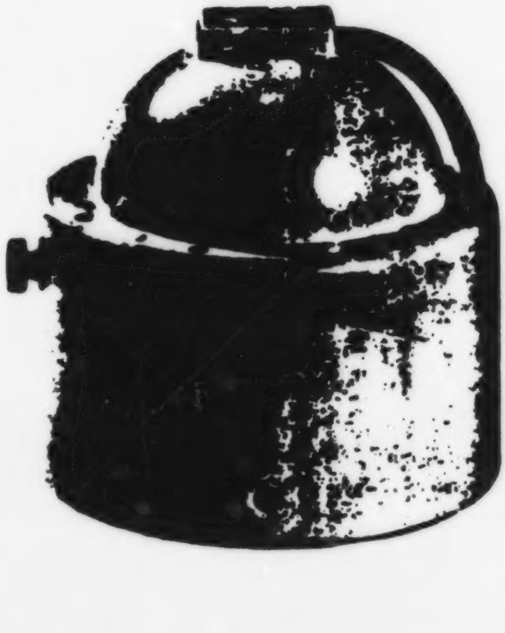
Model 101E Remote Magnetic Compass

PRELIMINARY INFORMATION

GENERAL DESCRIPTION

Magnetic compass, water and weatherproof for external installation on marine and land vehicles. Heading information is continuously transmitted over a 3-wire cable to one or more digital readouts. (A rotary repeater will soon be available.) With appropriate interfacing equipment, the 101E also affords a low-cost real time heading reference for most SAT/NAV systems.

A high degree of accuracy is achieved by locating the compass outside the major deviational forces of the hull and cargo. The binnacle contains corrector magnets to aid in compensating for external magnetic influences. Internal gimballing accomodates up to ± 55 degrees pitch and roll. Heading resolution is 1° with a repeatability of ±0.5 degrees.



Specifications

Diameter of spherical housing, including flanges:	165 mm (6.5").
Diameter of binnacle:	179 mm (7.0").
Height, including binnacle:	179 mm (7.0").
Weight, including binnacle:	2.04 kg (4.5 lbs.)
Movement:	Gimballed resolver
Response Time:	Less than 1 sec to 90°/sec turn
Gimballing:	55° ± 5° roll and pitch.
Resolution:	1°
Power consumption:	100 mw (approx) at 20 Hz sampling.
Voltage requirements:	4.5 VDC to 20 VDC.
Output format:	Serial pulse train, N + 1 pulses (N = heading in degrees).
Output signal frequency:	*Standard 20 KHz
Data sampling rate:	*Standard 20 Hz
Connections:	Input voltage, data output, ground.
Temperature limitations:	Operating, -40°C to +85°C Storage, -55°C to +85°C
Circuit protection:	Reverse polarity, overvoltage transients.
Housing:	Waterproof, U/V stabilized Lexan.®
Electronics Description:	uP does resolver-to-dig. conversion with auto zero/auto range. Exp. dig. averaging.

*Other options available. Consult factory.

DigiCOURSE, Inc. manufactures products under one or more of the following U.S. Patents 3 746 842 3 [illegible] 503 3 824 587 3 833 901 3 688 016 3 908 463 3 927 474 3 944 813 3 946 437 3 975 621 4 004 348 4 024 382 4 027 398 4 031 838 4 032 222 4 038 528 4 047 168 4 075 619 3 832 787 3 924 258 Other U.S. and foreign patents pending.

Model 101E
Remote Magnetic Compass

Operation

The 101E Remote Magnetic Compass uses three wires: Power, data and a common ground. 5 VDC power is supplied by, and data processed by, any of these DigiCOURSE units: Model 102A Digital Readout, Model 142 Averaging Digital Readout, and Model 261A Interrogator and Data Converter.

DigiCOURSE System 100 includes the Model 102A Readout and is recommended for stable applications where there is very little roll, pitch or yaw. See figure 1.

DigiCOURSE System 200 uses the Model 142 Averaging Readout and is recommended for shipboard and land vehicle use. See figure 2.

The Model 261A Interrogator and Data Converter can be used with either system or with the Model 101E Compass alone when it is desired to operate peripheral electronic equipment which requires data formats other than serial pulse train.

Figure 1. DigiCOURSE System 100E

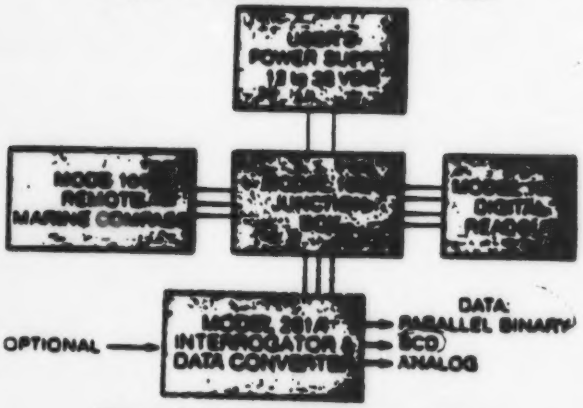
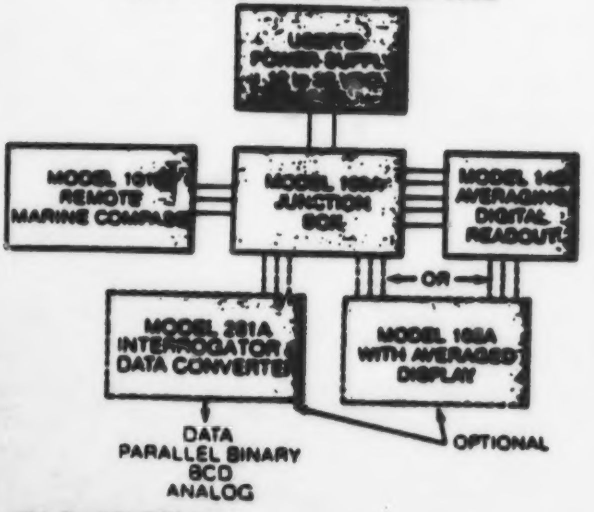
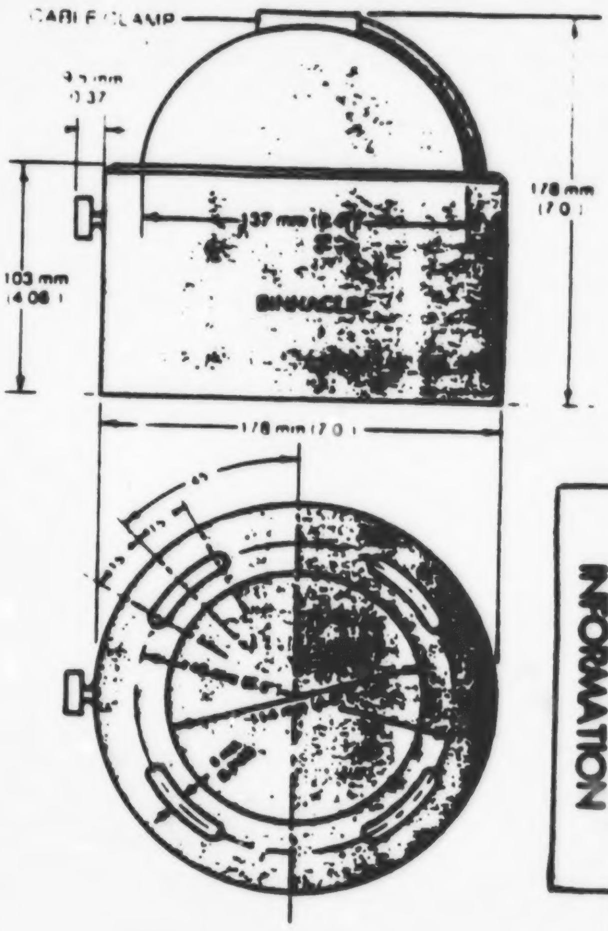

USER'S POWER SUPPLY 12 to 28 VDC
MODEL 101E REMOTE MARINE COMPASS
JUNCTION BOX
DIGITAL READOUT
OPTIONAL
MODEL 261A INTERROGATOR & DATA CONVERTER
DATA:
PARALLEL BINARY
BCD
ANALOG

Figure 2. DigiCOURSE System 200E


USER'S POWER SUPPLY
MODEL 101E REMOTE MARINE COMPASS
MODEL 103A JUNCTION BOX
MODEL 142 AVERAGING DIGITAL READOUT
OR
MODEL 261A INTERROGATOR & DATA CONVERTER
MODEL 102A WITH AVERAGED DISPLAY
DATA
PARALLEL BINARY
BCD
ANALOG
OPTIONAL

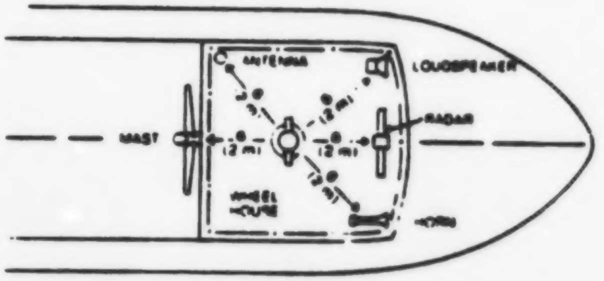
© 1983 DigiCOURSE, Inc

DIMENSIONS AND MOUNTING



PRELIMINARY INFORMATION

Desirable Compass Location



The compass and binnacle ideally should be mounted at least five feet (1.5m) above the deck on an appropriate non-ferrous pedestal (optional from DigiCOURSE) and located on top of the superstructure on the vessel's center line. The compass should be at least four and preferably six feet (1.2m to 2m) away from major steel objects, radar antennas and devices such as loudspeakers and horns with powerful permanent magnets.

APPENDIX F

MONTHLY REPORTS

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200. Telex 016-4596. Fax (709) 364-3550

February 15, 1989

Please reply quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

ATTENTION: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiments
Progress Report - January 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This progress report covers the period from December 9, 1988 to January 31, 1989.

Personnel

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician

Current Status of Work

To date work has been completed on a number of tasks which include the development of a detailed work plan and activity schedule together with the finalization of a project control chart. Work has started on the development of a detailed methodology and several discussions have been held with the USCG to seek their opinion on our proposed approach. Work has also started on the testing and acquisition of equipment. Tests have been performed on our computer navigation package and a number of discussions have taken place with Candel Industries Ltd. to finalize the required specifications of the LORAN-C buoys that NORDCO Limited will be purchasing. We have also done some preliminary investigation into a suitable experimental site and at present Notre Dame Bay, Newfoundland looks quite favourable.

At the end of January we calculate the work to have been 2.14% complete with approximately 11% of time elapsed. We expect the project to be completed within the established schedule and budget.

Work Planned for February 1989

In February we will be ordering four LORAN-C buoys and one Data Receiver from Candel Industries and discussions will be held with TDC/CCG to discuss details of the experiment and to finalize the experiment area and ship to be used. Work will continue on the development of the detailed methodology and testing of equipment.

Please find enclosed our claim for the period December 1988 to January 1989. If you have any questions, please do not hesitate to call.

Sincerely,

Duncan Finlayson

RF:rd

c.c. Mr. Mike Kelly - Superintendant SAR
Research and Development

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O Box 8833. St. John's. Newfoundland. Canada A1B 3T2 Telephone (709) 364-1200. Telex 016-4596. Fax (709) 364-3550

March 15, 1989

Please reply quoting
Ref. No.: 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

Attention: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

Re: SAR Object Motion Experiments
Progress Report-February 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This progress period covers the month of February, 1989.

PERSONNEL

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. FitzGerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician

WORK ACCOMPLISHED IN FEBRUARY, 1989

In early February a preliminary meeting was held in St. John's with Captain Bill Nash - Regional Manager of Search and Rescue Operations and NORDCO personnel D. Finlayson, J. Russell, and R. FitzGerald. The meeting was designed to outline the "SAR Object Motion Experiments" project and to find out if the Newfoundland Region would be interested in providing support to the project. Also in early February, a project kick-off meeting was held in Montreal between D. Finlayson and J. Russell of NORDCO Limited and Mr. Alfred Versailles and Mr. Mike Kelly.

NORDCO Limited received two complete Anemometer and Compass systems from the U.S. Coast Guard. These systems have been checked out and appear adequate for the project. Also, in February, four (4) LORAN-C drifter buoys and one (1) Data Receiver were ordered from Candell Industries Ltd. We expect 12-16 weeks delivery on the buoys and receiver.

At the end of February, we calculate the work to have been 12.71% complete with approximately 16% of the time elapsed. We expect the project to be completed within the established schedule and budget.

WORK PLANNED FOR MARCH, 1989

In March, work will begin on the development of a computer program to accommodate data retrieval and sorting from the four LORAN-C drifter buoys. Also, we hope to receive final word as to which Coast Guard Vessel will be available to the project. On finding out which vessel will be used, a trip to the vessel will be made. Work will continue on the development of the detailed methodology and testing of equipment.

Please find enclosed our claim for February 1989. If you have any questions, please do not hesitate to call.

Sincerely,

Ray Fitzgerald
for

Duncan Finlayson

DF/reb
Enclosure

c.c. Mr. Mike Kelly
Superintendent SAR Research
and Development

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P O Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4596, Fax (709) 364-3550

April 7, 1989

Please reply quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

ATTENTION: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiments
Progress Report - March 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This progress report covers the month of March, 1989.

Personnel

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician
D. Bryant - Senior Computer Programmer
M. Godinez - Computer Programmer
K. Elliott - Computer Programmer
D. Morrissey - Draftsperson

Work accomplished in March, 1989

In March, work started on the development of a computer program that will accommodate data retrieval and sorting from the four LORAN-C drifter buoys. Work has also started on the programming of the anemometer and compass systems received from the U.S. Coast Guard.

At present, NORDCO Limited is still waiting on word as to which Coast Guard Vessel will be made available for the experiment. During the latter part of March a meeting was held with Mr. Alfred Versailles and Mr. Mike Kelly, at which time an interim status report was presented. During discussions it was decided that only life rafts would be used as SAR objects for this years experiment.

At the end of March we calculate the work to be 15.66% complete, with approximately 23% of the time elapsed. We expect the project to be completed within the established schedule and budget.

Work planned for April, 1989

In April, computer programming work associated with data retrieval from the LORAN-C buoys will continue as will the programming of the anemometer and compass systems. We hope to receive final word as to the availability of a Coast Guard vessel and from there we will be able to somewhat finalize our experiment methodology and scheduling. Work will continue on the testing of equipment and work will begin on the configuration of equipment in the life raft.

Please find enclosed our claim for March, 1989. If you have any questions, please do not hesitate to call.

Sincerely,

for Ray Fitzgerald

Duncan Finlayson
Project Manager

DF:rd

Enclosure

c.c. Mr. Mike Kelly
Superintendent SAR Research
and Development

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4598, Fax (709) 364-3550

May 15, 1989

Please reply quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

ATTENTION: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiment
Progress Report - April 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This progress report covers the month of April, 1989.

Personnel

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician
D. Bryant - Senior Computer Programmer
M. Godinez - Computer Programmer
K. Elliott - Computer Programmer
D. Morrissey - Draftsperson
H. Jacobs - Electronics Technician
K. McCarthy - Computer Programmer

Work accomplished in April, 1989

In April NORDCO Limited was advised that the Coast Guard Cutter "Hood" would be made available for the experiment. Upon receiving authorization, visits were made to both the Coast Guard Cutter "Harp" in St. John's (sister ship of the "Hood") and the Coast Guard Cutter "Hood" on drydock in Clarenville. While visiting the Coast Guard Cutter "Hood" discussions were held between NORDCO personnel D. Finlayson, J. Russell and R. Fitzgerald and Captain D. Bowes-Lyon regarding the upcoming experiment. We believe the Coast Guard Cutter "Hood" to be well suited for the experiment.

Member of the SeaForest Group of Companies

Computer programming work associated with data retrieval from the LORAN-C buoys and the anemometer and compass systems is near completion.

Work began on the configuration of equipment in the life raft. Plywood floors were installed in both a four and a six-man life raft and space allocations were made for the anemometer system, LORAN-C buoy and ballast. We are expecting delivery of the four (4) LORAN-C buoys and VHF receiver by the end of May.

At the end of May we calculate the work to be 21.44% complete, with approximately 29% of the time elapsed. We expect the project to be completed within the established schedule and budget.

Work planned for May, 1989

Work will continue on outfitting the life rafts and designing an efficient deployment and retrieval method. The computer program for retrieving data from the anemometer and compass system will be tested in real-time. The experiment methodology and scheduling will be finalized. As mentioned earlier, we hope to have received the four (4) LORAN-C buoys and receiver by the end of May. Upon recepit of the equipment, testing of the position logging system will commence.

Please find enclosed our claim for April, 1989. If you have any questions, please do not hesitate to call.

Sincerely,

Duncan Finlayson
Project Manager

DF:rd

c.c. Mr. Mike Kelly - Superintendent SAR Research
and Development - Ottawa

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4596, Fax (709) 364-3550

June 13, 1989

Please reply quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

ATTENTION: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiment
Progress Report - May 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This progress report covers the month of May, 1989.

Personnel

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician
D. Bryant - Senior Computer Programmer
M. Godinez - Computer Programmer
K. Elliott - Computer Programmer
D. Morrissey - Draftsperson
H. Jacobs - Electronics Technician
K. McCarthy - Computer Programmer
J. Coombs - Machine Shop
R. Monks - Machine Shop
W. Tucker - Word Processing

Work accomplished in May, 1989

In May an efficient life raft deployment and retrieval system was designed, fabricated and dry land tested. The ballasting system for the life rafts was completed together with the raft mountings for the anemometer and navigation packages.

Computer programming work associated with data retrieval from the LORAN-C buoys and the anemometer and compass systems is near completion. All that remains is the delivery of the LORAN-C buoys before final bench testing can take place. The delivery of the LORAN-C buoys has been delayed by the supplier until the end of June.

On May 25th a meeting was held between D. Finlayson and J. Russell of NORDCO Limited and Captain William Nash of the Canadian Coast Guard in St. John's. The intent of the meeting was to present and discuss the detailed field plan and activity schedule. On May 28th, D. Finlayson presented and discussed the same plan with Mr. Alfred Versailles of TDC and Mr. Mike Kelly and Captain Joe McKenna of the Canadian Coast Guard at a meeting held at Canadian Coast Guard offices in Ottawa.

At the end of May we calculate the work to be 28.85% complete, with approximately 35% of the time elapsed. We expect the project to be completed within the established schedule and budget.

Work planned for June, 1989

As a result of discussions held in May, with regard to the field plan and activity schedule, an updated version will be circulated to all concerned on or about the middle of June. Mobilization of equipment and materials will begin in June. We expect to receive the LORAN-C buoys and VHF receiver by the end of June. Upon receipt final bench tests will be carried out.

Please find enclosed our claim for May, 1989. If you have any questions, please do not hesitate to call.

Sincerely,

Duncan Finlayson
Project Manager

DF:rd

c.c. Mr. Mike Kelly - Superintendent SAR Research
and Development - Ottawa

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4596, Fax (709) 364-3550

July 12, 1989

Please reply quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

ATTENTION: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiment
Progress Report - June, 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This progress report covers the month of June, 1989.

Personnel

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician
D. Bryant - Senior Computer Programmer
M. Godinez - Computer Programmer
K. Elliott - Computer Programmer
D. Morrissey - Draftsperson
H. Jacobs - Electronics Technician
K. McCarthy - Computer Programmer
J. Coombs - Machine Shop
R. Monks - Machine Shop
W. Tucker - Word Processing
H. Jennings - Machine Shop
D. Beck - Electronics Technician
G. Winter - Machine Shop
R. Soper - Technician

Work accomplished in June, 1989

In June, an updated version of the field plan and activity schedule was circulated to all concerned parties.

Computer work associated with data retrieval from the anemometer and compass systems has been completed and tested. The wave monitoring system has also been assembled and tested. All equipment with the exception of the LORAN-C buoys is now field ready. The delivery of the LORAN-C buoys was again delayed by the supplier until the second week in July. As of the date of this report we now have the LORAN-C Drifting buoys and VHF Receiver at our premises. Initial laboratory tests on the Loran-C Buoys suggests that all units function properly.

At the end of June we calculate the work to be 58.7% complete with approximately 42% for the time elapsed. We expect the project to be completed within the established schedule and budget.

Work planned for July, 1989

In July, bench testing of the LORAN-C buoys will be performed and computer programming work associated with data retrieval from the LORAN-C buoys will be completed. After all in-house tests are performed NORDCO personnel will proceed to Notre Dame Bay to begin the field portion of the program.

Please find enclosed our claim for June, 1989. If you have any questions on this matter please do not hesitate to call.

Yours sincerely,

Ray Fitzgerald

for Duncan Finlayson
Project Manager

DF:cj
Enclosure

cc Mr. Mike Kelly
Superintendent SAR Research and Development - Ottawa

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4596, Fax (709) 364-3550

August 17, 1989

Please reply quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

ATTENTION: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiment
Progress Report - July, 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This progress report covers the month of July, 1989.

Personnel

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician
D. Bryant - Senior Computer Programmer
M. Godinez - Computer Programmer
K. Elliott - Computer Programmer
D. Morrissey - Draftsperson
H. Jacobs - Electronics Technician
K. McCarthy - Computer Programmer
J. Coombs - Machine Shop

Member of the SeaForest Group of Companies

R. Monks - Machine Shop
W. Tucker - Word Processing
H. Jennings - Machine Shop
D. Beck - Electronics Technician
G. Winter - Machine Shop
R. Soper - Technician
M. Hancock - Word processing

Work accomplished in July, 1989

At the beginning of the month, the four Sea Rover 3 LORAN-C drifting buoys, which were originally to be delivered in mid-May, had not been received from the manufacturer, Candec Industries Limited of Sydney, B.C. As a consequence of the late delivery, the start date of the leeway experiment field program was re-scheduled from July 06 until July 19, 1989. In early July, final checks were made of all other field equipment. The LORAN-C buoys were received on July 10, 1989. From July 10th to the 18th, laboratory testing of the new LORAN-C buoys was carried out. The tests suggested that the buoys were functioning properly; however, late on Tuesday July 18th, one of the buoys failed completely. After consulting with the manufacturer, the buoy was shipped back for repair early the following day. In spite of this failure, it was decided to proceed to Twillingate with the three remaining buoys to conduct the initial field trials. The field party; consisting of Fitzgerald, Finlayson, Russell, and Tucker; arrived on board the CCG SAR Cutter "Hood" late on the evening of July 19, 1989.

Mobilization of the ship for the experiment began Thursday morning July 20 and was completed on Sunday, July 23, 1989. On July 23, the wave measuring buoy mooring was deployed in position latitude 49 50.5'N, longitude 54 50.0'W in a water depth of 356 metres. In addition, the deviation of the shipboard anemometer system fluxgate compass was determined using the ship's gyrocompass, some initial deployment/recovery trials were made with an instrumented four-person liferaft, and a drift comparison test was made between a LORAN-C drifting buoy and an array of plywood drift cards.

On Monday, July 24, various equipment and software adjustments were made. The wave measuring buoy was deployed on the mooring and was found to be functioning normally. The first leeway drift run was conducted in the evening using a four-person liferaft equipped with a LORAN-C buoy and an anemometer system. For this initial trial only one LORAN-C drifting buoy was deployed in the water; a second buoy was used to log the position of the ship during the drift run.

The following morning, July 25, 1989, the wind velocity data and the vessel heading data for the liferaft and the ship were down loaded to the microcomputer system. The position data stored in the LORAN-C buoy RAM was down loaded as well. The data from two of the units was successfully down loaded; although it was noted that the clocks were not keeping the correct time. When an attempt was made to down load data from the buoy that had been mounted in the liferaft, it was found that no communication with the buoy could be established. Numerous attempts were made but to no avail. The manufacturer was called several times during the afternoon and evening to obtain some guidance in correcting the problem. No solution was found. This buoy was the second to fail since their delivery 15 days earlier.

Wednesday, July 26, 1989 was a crew change day for the vessel. As well, CCG electronics technicians arrived to improve the internal communications system aboard the ship. Fitzgerald and Russell took the opportunity to travel to Gander to air express the non-functioning LORAN-C buoy back to the manufacturer in British Columbia. The CCG vessel "Hood" was required to respond to two SAR calls and was away from Twillingate from 1630 local time until the 0540 following morning.

The ship departed Twillingate for the experiment area at 0630 local time on July 27, 1989. An instrumented liferaft with one LORAN-C buoy and the one remaining buoy were deployed at 0835 local time. The drift run continued in generally light wind conditions until 1744 local time. In a comparison with a plywood drift card equipped with a ballasted two axis keel extending to a depth of 2 feet, the free drifting buoy was found to experience leeway due to the drag of the floatation collar. The wave measuring buoy was recovered from the mooring and replaced with a dummy buoy in order to avoid damage during the experiment break period.

The field party returned to St. John's on the last day of the month to carry out modifications to the buoys and the leeway position processing program software.

At the end of July we calculate that the work is 70% complete with approximately 48% for the time elapsed. We expect the project to be completed within the established schedule and budget.

Work planned for August, 1989

Prior to returning to the field in mid-August, we intend to add fins to the body of the LORAN-C buoys to increase the frontal area to the surface current so as to increase the water drag coefficient. In addition, we will add more powerful error checking routines for the incoming data transmitted from the LORAN-C buoys.

Please find enclosed our claim for July, 1989. If you have any questions on this matter please do not hesitate to call.

Yours sincerely,

Duncan Finlayson
Project Manager

DF:mcb
Enclosure

cc: Mr. Mike Kelly
Superintendent SAR Research and Development - Ottawa

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4598, Fax (709) 364-3550

October 5, 1989

Please Reply Quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

Attention: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiment
Progress Report - August, 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This progress report covers the month of August, 1989.

Personnel

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician
D. Bryant - Senior Computer Programmer
M. Godinez - Computer Programmer
K. Elliott - Computer Programmer
D. Morrissey - Draftsperson
H. Jacobs - Electronics Technician
K. McCarthy - Computer Programmer
J. Coombe - Machine Shop
R. Monks - Machine Shop
H. Jennings - Machine Shop
G. Winter - Machine Shop
M. Hancock - Word Processing

Member of the SeaForest Group of Companies

Work Accomplished in August, 1989

During the first half of August, the four (4) Loran-C buoys were returned to the manufacturer in British Columbia to have the problems identified in the July field work corrected. The buoys were returned to NORDCO Limited on August 15. Also, during this period, software modifications were made to the computer program. Aluminum fins were designed and fabricated that were intended to increase the frontal area to the surface current so as to increase the water drag coefficient. Finally, this first half of August was used for a preliminary review of the initial field data.

On August 17, NORDCO personnel D. Finlayson, J. Russell and R. Fitzgerald travelled to Twillingate. Re-mobilization of the CCGC Hood took place on August 18 and 19. During this period, the new aluminum fins were attached to the buoys, the navigation system was tested, the waverider buoy was re-deployed and a buoy leeway test was conducted.

On August 20, the first drift run (run 03) for this field trip was conducted. The leeway computer program was giving some problems, and it was decided on August 21 to have a programmer come to the CCGC Hood from NORDCO Limited. Drift runs still continued. During the evening of August 22, M. Godinez of NORDCO Limited arrived onboard as did Dr. A. Allan of the United States Coast Guard (USCG). Dr. Allan was onboard to observe the experiment. Mr. Godinez and Dr. Allan departed the CCGC Hood on the evening of August 24.

Three full days were lost during the August field trip. Two days were attributed to poor weather while a third was due to a SAR call. NORDCO personnel returned to St. John's on August 31.

Generally speaking, the experiment went well during the August field trip with eight (8) drift runs being conducted. At the end of August, we calculated the work as being 80% complete with approximately 55% of the time elapsed. It is expected that the project will be completed within the established schedule and budget.

Work Planned for September, 1989

In September, it is planned that the field portion of the program will be completed. Also it is expected that a start will be made in writing the field report and tabulating the field data. The general plan is for NORDCO personnel to return to the CCGC Hood on September 8, perform drift runs from September 9 to 17 and demobilize the ship and return to St. John's on September 18 and 19.

Yours sincerely,

R. Fitzgerald

for Duncan Finlayson
Project Manager

DF:emh

c: Mr. Mike Kelly
Superintendent, SAR Research and Development-Ottawa

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4596, Fax (709) 364-3550

October 12, 1989

Please Reply Quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

Attention: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiment
Progress Report - September, 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This Progress Report covers the month of September, 1989.

Personnel

D. Finlayson - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
B. Dawe - Project Consultant
J. Lundy - Electronics Technician
R. Tucker - Electrician
D. Bryant - Senior Computer Programmer
M. Godinez - Computer Programmer
K. Elliott - Computer Programmer
D. Morrissey - Draftsperson

Member of the SeaForest Group of Companies

H. Jacobs - Electronics Technician
K. McCarthy - Computer Programmer
J. Coombs - Machine Shop
R. Monks - Machine Shop
H. Jennings - Machine Shop
G. Winter - Machine Shop
M. Hancock - Word Processing

Work Accomplished in September, 1989

During the period September 1-7, some software modifications were made to the data logging routines. These modifications pertained to the life raft wind and compass data.

On September 8, the NORDCO field party consisting of D. Finlayson, J. Russell and R. Fitzgerald, travelled to Twillingate. Re-mobilization of the CCGC "Hood" took place on the morning of September 9, and the first drift run (run 11) of the final field trip was conducted in the afternoon.

On September 12, the CCGC "Hood" developed engine problems. In the late afternoon of September 13, the CCGC "Hood" was declared serviceable. Drift runs resumed the following day. The waverider buoy was recovered on September 15 and the final drift run (run 16) of the experiment was conducted on September 17. Immediately following the final drift run, demobilization of the CCGC "Hood" began. On September 18, all equipment was loaded aboard a rental truck and the NORDCO field party departed for St. John's.

After the field party returned from Twillingate, work was started on the cruise report and tabulation and reduction of the field data. At the end of September, the work is estimated as being 85% complete with approximately 61% of the time elapsed. It is expected that the project will be completed within the established schedule.

Work Planned for October, 1989

In October, it is planned that the cruise report will be completed and submitted to TDC and CCG. Work will continue on the tabulation and reduction of the field data.

Please find enclosed our claim for September, 1989. If you have any questions on this matter, please do not hesitate to call.

Yours sincerely,

Byron

Byron Dawe
Project Manager

BD:mcb

cc: Mr. Mike Kelly
Superintendent, SAR Research and Development - Ottawa

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4596, Fax (709) 364-3550

October 26, 1989

Please Reply Quoting
Ref. No. 289-88G

Canadian Coast Guard
Search and Rescue
Canada Building, Minto Place
344 Slater Street
Ottaw, Ontario
K1A 0N7

Attention: Mr. Mike Kelly
Superintendent
SAR Research and Development

Dear Mr. Kelly:

RE: Cruise Report
SAR Object Motion Experiment
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

Please find enclosed, for your review, one (1) copy of the above captioned report which describes the field work associated with the SAR Object Motion Experiment. This report will be an appendix to the final report. If you have any questions, please contact us at your convenience.

Yours sincerely,

Byron

Byron Dawe
Project Manager

BD:emh
Enclosures

Member of the SeaForest Group of Companies

NORDCO Limited
Newfoundland Oceans Research and Development Corporation
P. O. Box 8833, St. John's, Newfoundland, Canada A1B 3T2 Telephone (709) 364-1200, Telex 016-4596, Fax (709) 364-3550

November 13, 1989

Please Reply Quoting
Ref. No. 289-88G

Transport Canada
Transportation Development Centre (TDC)
Guy-Favreau Complexe
200 West Rene Levesque Blvd.
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4

Attention: Mr. Alfred Versailles
Senior Development Officer
Advanced Technology Division

Dear Mr. Versailles:

RE: SAR Object Motion Experiment
Progress Report - October, 1989
SSC File No. 14SD.T8200-8-8527
Serial No. T8200-8-8527/01-SD

This Progress Report covers the month of October, 1989.

Personnel

B. Dawe - Project Manager
J. Russell - Assistant Project Manager
R. Fitzgerald - Field Manager
J. Lundy - Electronics Technician
R. Tucker - Electrician
D. Bryant - Senior Computer Programmer
M. Godinez - Computer Programmer
K. Elliott - Computer Programmer
D. Morrissey - Draftsperson
H. Jacobs - Electronics Technician
K. McCarthy - Computer Programmer
J. Coombs - Machine Shop
R. Monks - Machine Shop
H. Jennings - Machine Shop
G. Winter - Machine Shop
M. Hancock - Word Processing

Member of the SeaForest Group of Companies

Work Accomplished in October, 1989

During the period October 3rd and 4th, a meeting was held in St. John's with Mr. Mike Kelly, Canadian Coast Guard and Dr. Quincy Robe, United States Coast Guard. The purpose of the meeting was to brief Mr. Kelly and Dr. Robe on the Leeway experiment to date and to discuss the joint SAR detection exercise tentatively slated for the fall of 1990. A similiar meeting was held on October 24th with Mr. Alfred Versailles, Transportation Development Center and Captain Joe McKenna, Canadian Coast Guard.

The cruise report dealing with the field work associated with the Leeway experiment was completed in October. Draft copies of the report were delivered to Mr. Mike Kelly and Mr. Alfred Versailles. Work continued on the tabulation and reduction of field data.

Work Planned for November, 1989

Work will continue on the tabulation and reduction of the field data. Work will start on the data analysis.

Please find enclosed our claim for October, 1989. If you have any questions regarding this matter, please do not hesitate to contact me.

Yours sincerely,

Byron

Byron Dawe
Project Manager

BD:cj
Enclosure

cc: Mr. Mike Kelly
Superintendent
SAR Research and Development
Ottawa

APPENDIX G

FIELD LOGS

PHOTO LOG

SAR
LEEWAY EXPERIMENT
1989

RUN # ________________

DATE ________________

ROLL # ________________

TIME	FRAME #	SUBJECT	REMARKS	OBS

SAR
OBJECT DEPLOYMENT
CHECKLIST

RUN # ____________________

DATE ____________________

TARGET TYPE ____________________

CK.	NO.	ITEM
	1	DUMMY GAS BOTTLE ATTACHED.
	2	INSTRUMENT PACKAGE AND MOUNTING SECURE.
	3	LORAN - C ANTENNA AND ANEMOMETER SECURE.
	4	LUBBERS LINE ON COMPASS ALIGNED WITH HEADING MARK ON RAFT.
	5	INITILIZE AND TEST WIND MEASURING SYSTEM.
	6	INITILIZE AND TEST NAVIGATION SYSTEM.
	7	FLOOR INFLATED.
	8	BOUYANCY CHAMBERS TOPPED OFF.
	9	BALLAST EVENLY AND SECURELY STOWED.
	10	CANOPY SEALED AROUND ANEMOMETER MAST AND LORAN - C BUOY.
	11	DOOR SECURED. (ie. OPEN OR CLOSED)
	12	DROGUE SECURELY FASTENED. (IF USED)
	13	DROGUE STREAMED UNFOULED (IF USED)

REMARKS

LORAN C BUOY
INITIALIZATION CHECK LIST
LEEWAY EXPERIMENT 1989

NORDCO

RUN # ____________

DATE ____________

COMMAND	BUOY #'s			
	22	24	26	28
SET - ID				
READ BATTERY				
SET - GRI				
SET - TX1				
TIME -				
(GMT)				
(BUOY TIME)				
(DIFFERENCE)				
(RESET TIME)				
CLEAR MEM				
READ LORAN				
LOG - ON				

REMARKS

SAR
OBJECT DEPLOYMENT / RETRIEVAL LOG

RUN # ____________

DATE ____________

START TIME ______ ; END TIME ______

LIFERAFT TYPE ____________

LIFERAFT SER. # ____________

WEIGHT OF RAFT AND INSTRUMENT PACKAGE ____________ lb.

DEPLOYMENT

SIMULATED NUMBER OF PERSONS ON BOARD ____________

WEIGHT OF BALLAST ____________ lb.

INITIAL DISPLACEMENT ____________ lb.

TRIM ____________

DOOR OPEN / CLOSED ____________

DROGUE DEPLOYED / NOT DEPLOYED ____________

OBSERVED DRAFT ____________ ft.

ESTIMATED DROGUE DEPTH ____________ in.

RETRIEVAL

ESTIMATED DROGUE DEPTH ____________ ft.

OBSERVED DRAFT ____________ in.

TRIM ____________

ESTIMATED AMOUNT OF WATER SHIPPED ____________ lb.

FINAL DISPLACEMENT ____________ lb.

DOOR OPEN / CLOSED ____________

CONDITION OF BUOYANCY RINGS ____________

CONDITION OF CANOPY ____________

CONDITION OF INSTRUMENTATION ____________

REMARKS

NORDCO

LORAN C BUOY
DEPLOYMENT / RETRIEVAL LOG

LEEWAY EXPERIMENT 1989

RUN # ____________

DATE ____________

BUOY #	RETRIEVAL TIME	DEPLOYMENT TIME	REMARKS